

Maryland's Unique Biodiversity

SUMMARY: Maryland—a small state—is home to a disproportionately large number of different native plant species and ecological communities. The current character of Maryland's natural environment is not only a tale of habitat loss through direct conversion, fragmentation and unwitting destruction by development and altered landscapes in modernity but also a tale of Maryland's historical landscape and the ebb and flow of climatic shifts in geological time.

The Wildlife and Heritage Service of Maryland's Department of Natural Resources is responsible for the identification, ranking, and protection of rare and endangered species and natural communities in Maryland. The Service currently lists 710 plant species, using a classification system that condenses a large quantity of useful information into shorthand form. Nearly 28% of Maryland's plant species are listed as rare, threatened, endangered, or extirpated. Due to historical differences in the treatment of plants and animals, plants receive less conservation protection and less funding than animals. Thus, although active conservation efforts can be successful, especially if supported by research, it is often impossible to do otherwise than simply observe and record the permanent disappearance of our botanical heritage.

Why are there so many rare plants in Maryland?

This simple question is answered by looking at the breadth of native plant¹ communities that are contained within our boundaries. Maryland's contribution to regional biodiversity is far greater than its small size would suggest. Maryland ranks among the smaller states (42/50), and when compared with our close neighbors, Pennsylvania and Virginia, we are not only smaller, we are more densely populated (U.S. Census 2010). Yet Maryland tracks some 710 taxa of rare, threatened and endangered plant species, almost as many as Pennsylvania (793), which is 4 times the size of Maryland and not far from the number tracked by Virginia (909), which is more than 3 times the size of Maryland (PA Natural Heritage Program; VA Natural Heritage Resources).

Owing to Maryland's latitude, its plant communities contain elements of both northern and southern floras. Owing to its longitude, Maryland intercepts six distinctly different ecological regions from the barrier islands along the Atlantic Coast west to the high elevations of the Allegheny Plateau. (See map in Appendix 2.)

Additional floristic complexity is due to the ebb and flow of climatic changes over geological time. Maryland was located south of the limit of glaciers during the Pleistocene Epoch (ending 11,700 years before present (ybp)) and served as a refuge for migrating plant and animal species. Many of these remain as part of our botanical heritage today. More recent climatic changes are also evidenced in our flora. During the interval ending 3200 ybp, Maryland was much warmer and much drier than it is today. Species from the midwestern prairies became part of the

¹ In the context of this Report, a 'native' plant is one that occurs naturally in the State without direct or indirect human intervention.

Maryland flora, and many of those species remain in unique natural communities today (Droege et al. 2009). Finally, the flora has been modified by centuries of habitation, not only by European and African settlers, but earlier by Native Americans who farmed, hunted and actively managed the Maryland landscape (Anderson et al. 1999, Curry 1992).

The character of Maryland's pre-settlement (pre-1634) forests and the degree of active management by fire or clearing by Native Americans is a matter of some controversy. Brush (2001) suggests that with the exception of serpentine barrens and tidal marshes the early settlers encountered a densely forested landscape. Droege et al. (2009) suggested that sites along the Patuxent River were open sandy barrens and woodlands due to intensive management by Native Americans.

Early settlers sometimes commented on the densely forested landscape (Frick et al. 1987):

“all the low land [referring to the general landscape of the Coastal Plain] is verry woody like one continued forrest, no part clear but what is cleared by the English. An tho we are pretty closely seated, yett we cannot see our next neighborurs house for the trees.”

Others characterized the landscape as being forested by large widely spaced trees (3 March 1634, A Briefe Relation of the Voyage unto Maryland, MSA SC 2221-17-5).

“there are noe marshes or swampes about it, but solid firme ground, with great variety of woode, not choaked vp with vndershrubs, but commonly so farre distant from each other as a coach and fower horses may travale without molestation.”

Colonists living in the upper bay along the Susquehanna River reported entering a great expanse of barren lands (Marye 1955, Porter 1975):

“from the headwaters of the Patapsco, Gunpowder and Bush River west to the Monocacy there lay a vast body of barrens with no timber thereon.”

These barrens as mapped (Porter 1975) extended from the Susquehanna and north of Baltimore west across Harford, Baltimore and Carroll Counties to the headwaters of the Monocacy River. So impressive was this expanse that some scholars have concluded that the barrens were responsible for delayed settlement of western Maryland (Porter 1979). They likely attributed the barrenness of the landscape to lack of fertility but it is more probable that the barrens were simply a large area burned over by Native Americans in pursuit of game (Porter 1979, Tyndall 2005). These differences between observations may lie not so much in a comprehensive characterization of the land but in the perception of peoples living in different parts of Maryland, who had no maps but a necessary awareness of their own local geography.

Estimates of the number of Native Americans historically living along the Chesapeake Bay varies greatly among scholars and ranges from 8000 to over 50,000 (Feest 1978, MSA SC 2221-17-1). The actual population is less important than the impact that these peoples had upon the landscape. The presence of the “great barrens” (Marye 1955) suggests that, at least in some parts of Maryland, they managed large areas. Whatever the impact of Native American populations on the landscape, it ended abruptly as evidenced by this chilling passage in a letter dated 23 January 1698 (Letter from Hugh Jones (Calvert County, Maryland) to Benjamin Woodroffe, Principal of Gloucester Hall, Oxford, England. 23 January 1698):

“as for our predecessors, the Indians, I cannot give you at present any further account of them than this, viszt. that whereas att the first seating of Maryland there were several

nations of Indians in the country governed by several petty Kings, now I doe not thinke that there are five hundred fightinge men of them in the province , and those are most on the Eastern Shore where they have two or three little towns” “the small pox alsoe has swept away a great many , so that now they are dwindled to almost to nothing.”

Sources of complexity in Maryland flora

Summary: To understand the complexity of the Maryland flora, it helps to look at some particular kinds of examples. These are the disjunct species, the peripheral species, and species that occupy singular or regionally endemic ecosystems. A few illustrative examples are provided for each.

Disjunct plant species

Summary: “Disjunct” plant species make an important contribution to Maryland’s complex flora. These are species that occur with marked geographic separation from their core species range and these populations may be ecologically divergent as well. This phenomenon is often explained by long-distance species migrations during major historical climatic shifts, and these shifts contributed to Maryland’s botanical diversity in significant ways. What follows are some of the best-studied and most compelling examples.

One of the more striking Maryland disjuncts is the Nantucket shadbush (*Amelanchier nantucketensis*) (Figure 6). This species occurs discontinuously along the Atlantic Coast from Nova Scotia to Long Island, New York, and was once considered restricted to the previously glaciated regions of New England. (With rare exceptions this remains true.) In Maryland this species occurs in a relict population in the Potomac Gorge along the ancient bedrock terrace forests and outcrops of Mather Gorge. These habitats perhaps mimicked the rocky, barren habitats of New England upon retreat of the ice sheets and likely served as a refuge during the last glacial maximum. Whatever the mechanistic details of the species arrival in Maryland, the presence of this species is fascinating not only to the bio-geographer but to anyone having the imagination to conjure up a landscape containing mammoths and bison.

This general pattern is reflected in the distribution of the federally endangered swamp pink (*Helonias bullata*) (Figure 6). This plant occurs along the Fall Line (where Piedmont gives way to the Coastal Plain) in Maryland in a series of seepage swamps (with surface flow of spring-fed water). This population is now widely disjunct from the most genetically diverse populations located in the Southern Appalachians (Godt et al. 1995, Hamrick and Godt 1996).



Figure 6. Three of Maryland's rare disjunct species. From left to right: Nantucket shadbush, *Amelanchier nantucketensis*, Photo by Christopher Frye; Showy goldenrod, *Solidago speciosa*, Photo by Kerry Wixted; swamp pink, *Helonias bullata*, Photo by Kerry Wixted.

One of the most influential climatic events on Maryland's flora was the pronounced warming period called the Hypsothermal Interval during which some midwestern plant species expanded their ranges eastward. The average temperature during this interval may have been up to 5° F warmer than today and precipitation levels may have dropped by as much as 25%. Consequently, a number of species more frequently associated with midwestern prairies now occur in Maryland in disjunct populations. An example is pale false foxglove (*Agalinis skinneriana*), which occurs in Maryland in small populations in sandy barrens of the Coastal Plain. Pettingill and Neel (2008) found that the plants occurring in Dorchester County on Maryland's Eastern Shore were genetic sisters to a population of plants from Missouri. The core range of *A. skinneriana* is in the central United States.

The Maryland flora also contains populations of midwestern species that are large enough or extend over such a significant geographic area as to be considered a separate part of the species range. For example, Virginia nailwort (*Paronychia virginica*) occurs in disparate zones, one centered around the Potomac River (MD, VA, WV), one in northern Georgia and Alabama and one zone around Missouri and Arkansas (NatureServe 2013).

The final example, showy goldenrod (*Solidago speciosa*) (Figure 6) relates to modification of the environment by Native Americans and is an example of a within-state disjunct. This species was long-thought to be restricted to southern Maryland in prairie-like habitats persisting in artificially maintained right of ways. However, McAvoy and Harrison (2012) discovered the species over Native American shell-middens on the Eastern Shore. This finding is fascinating because the shell-middens were manmade, created by dumping oyster shell in the same locations over thousands of years—time enough for these habitats to intercept and retain elements of an advancing western flora.



Figure 7. Canada yew, *Taxus canadensis*, a rare and threatened peripheral species that currently exists only in locations inaccessible to white-tailed deer. Photo by Peter Stango.

Peripheral plant species

Summary: Maryland’s latitude places it at the southern end of northeastern ecosystems and the northern end of southeastern ecosystems. Whether a species hails from the north or the south, the Maryland flora is replete with examples of species at or near their natural range limits, in what biologists call “peripheral” populations.

The famous English naturalist John Ray (1627-1705) illustrated a new world plant species delivered to him from the Maryland colony in 1688. The species was Spanish moss (*Tillandsia usneoides*) and within the Maryland catalogue Ray also discusses Galax (*Galax urceolata*) (Brown et al. 1987). According to Brown et al. (1987),

“apparently the colonial naturalists collected only on the coastal plain of Maryland. . . [Most importantly,] as the geographic attributions accompanying their specimens always refer to Maryland, we can only conclude that the species known today only from southeastern Virginia must have occurred in Maryland in the past.” (p 248)

These examples are extraordinary not only because neither species has been seen in Maryland for centuries but also because both of these species very likely reached their northern range limits in Maryland.

The mountains of Garrett County provide excellent examples of northern species that occur in peripheral populations. Some of the more striking examples are buckbean (*Menyanthes trifoliata*), and Canada yew (*Taxus canadensis*) (Figure 7). Both of these species are restricted to Garrett County near the southern ends of their natural ranges. Maryland populations of buckbean and Canada yew form part of these species discontinuous southern ranges. The Coastal Plain contains multiple examples of species reaching both their southern and northern range limits. For example, northern golden heather (*Hudsonia ericoides*) a common low shrub ranging from Newfoundland through New England, is restricted to southern Maryland at its southern range limit (Weakley 2010 reports a single disjunct location in South Carolina). Pondspice (*Litsea aestivalis*) (Figure 8), a rare southeastern coastal shrub, is found at a single station on the Eastern Shore at its northern range limit. A final example, sourwood (*Oxydendrum arboreum*), may reflect two different periods of migration. A characteristic and common subcanopy tree south of Maryland, the few, scattered Maryland records represent remnant populations near the northern range limit.



Figure 8. Pondsice, *Litsea aestivalis*, a rare southeastern coastal shrub is found at a single station on the Eastern Shore at its northern range limit. Photo by Christopher Frye.

Singular plant communities

Summary: Maryland contains valuable “singular” plant communities, which are occupied by a number of very rare plant species, among which may be peripheral and disjunct plant species. Soldiers Delight Natural Environmental Area is an outstanding example.

Of the “Great Barrens” of Maryland (Marye 1955) that at one time covered approximately 250,000 acres (Tyndall 2005), a remnant of about 1000 acres remains at Soldier’s Delight Natural Environmental Area (SD). SD is a landscape of natural grasslands and oak savanna over the largest outcrop of serpentine in the eastern United States (Tyndall 2005). Now heavily fragmented and greatly altered by fire suppression and the resulting invasion by Virginia pine (*Pinus virginiana*), it remains a singular plant community occupied by a number of very rare plant species. Among these species are excellent examples of peripheral and disjunct plant species.

For example, SD holds the nation’s largest population of the federally endangered sandplains gerardia (*Agalinis acuta*). This species is distributed in a series of disjunct populations from the District of Columbia (historical) and Maryland north to Massachusetts. Several sedge species are nearly restricted to the SD grasslands. Mead’s sedge (*Carex meadii*) occurs at SD in the state’s largest and most viable population and Richardson’s sedge (*Carex richardsonii*) is entirely restricted to SD. Both species are components of midwestern prairies and occur in Maryland as populations disjunct from their core ranges. Additionally, SD contains the largest population of interior sedge (*Carex interior*), a peripheral species (from the north) that additionally represents an interesting ecological shift in the species habitat. *C. interior* occurs as a very common wetland plant in the northeastern United States but has highly restricted habitat in Maryland occurring only in sites with ultramafic (high nutrient content of the soils) substrates like serpentine and diabase. This latter situation is illustrative of the concept behind state ranks, which is to capture as much of the adaptive genetic variation in species as possible, thus potentially allowing the species to adapt to changes in climate or other anthropogenic changes in habitat.

The character of the soils, particularly those soils rich in calcium, gives rise to a number of diverse plant communities. For example, limestone bluffs and rich forests in the limestone region of Maryland (essentially the northern extension of the Blue Ridge in Washington County) are unparalleled in overall species richness. Engelhardt (2004) found over 110 species of vascular plants in a single 20 x 50 meter plot along Antietam Creek in Washington County. Many of the

rare plants at this location are obligate calciphiles (calcium-loving). For example, Hitchcock's sedge (*Carex hitchcockiana*) occurs in large populations along with a profusion of wildflowers. Calcium-bearing soils in dry, exposed habitats such as cliffs or steep slopes also give rise to unique plant communities. For example, arbor-vitae (*Thuja occidentalis*), a nearly ubiquitous species of bogs and wetlands in the northeastern United States, is highly restricted to limestone bluffs and outcrops, particularly along the Potomac River. The globally rare tall larkspur (*Delphinium exaltatum*) occurs in limestone woodlands along with a variety of habitat-restricted species including the running serviceberry (*Amelanchier humilis*), which reaches its southern range limit in Maryland and adjacent West Virginia.

Some plant communities have been entirely extirpated, not during pre-colonial times but recently. These "historical" plant communities may only be reconstructed through the cataloging of museum specimens. For example, during a period ranging from approximately 1888 to 1921 a number of species were collected in the vicinity of Mountain Lake Park in the southern Garrett County. Amongst these species were Kalm's brome grass (*Bromus kalmii*) and fringed brome (*Bromus ciliatus*). Neither of these species has been seen since 1921. In association with these collections we find multiple collections of the state-endangered Indian paint brush (*Castilleja coccinea*), along with a group of species now considered extirpated including spotted joe-pyeweed (*Eutrochium maculatum*), American lovage (*Ligusticum canadense*) and another striking disjunct from the Midwest, downy gentian (*Gentiana puberula*). Apparently, this was once the site of a prairie-like grassland and calcium-rich wetland—now extirpated by the construction of a reservoir and use of the area as a landfill.

Regionally endemic plant communities

Summary: An "endemic" native plant community is one that occurs in only one location on earth. Several of these are known in Maryland. In all likelihood, others have been lost without ever having been discovered.

Of the native plant communities endemic to the region, the intertidal habitats (occurring along the shorelines between low and high tides) along the Chesapeake Bay and its tidal tributaries comprise a distinctive set of globally rare and near-endemic species. Seaside alder (*Alnus maritima* ssp. *maritima*) is a wetland shrub restricted to tidal rivers on the Eastern Shore and Delaware. Two other subspecies have disjunct populations occurring in Georgia (ssp. *georgiensis*) and Oklahoma (ssp. *oklahomensis*). This odd distribution is thought to be the result of range retraction during a glacial epoch leaving stranded populations in disparate locations that have now diverged genetically and ecologically (Schrader and Graves 2004). Another globally rare species is the regional endemic Maryland bur-marigold (*Bidens bidentoides*) that occurs in the upper Chesapeake Bay, Delaware Bay and few stations in New Jersey and New York. Maryland has the lead responsibility for ranking this species as Maryland populations comprise the bulk of individuals within its narrow range. Also in intertidal habitats lives federally threatened sensitive joint-vetch (*Aeshynomene virginica*), which occurs from New Jersey south to North Carolina but is currently extant in only 20 locations (NatureServe 2013). Additionally, the Chesapeake Bay contains many relatively common species that occur over vast areas in freshwater, brackish water and saltwater marshes.

On the Eastern Shore of Maryland occur a group of natural wetlands called Delmarva Bays. These are shallow, seasonally flooded, freshwater wetlands that are generally small (< 1 acre) but

numerous, with an estimated 1500-2500 ponds present on the Delmarva Peninsula (McAvoy and Bowman 2002). The plants of these bays are adapted to a seasonal drawdown of the groundwater with extreme variation in dominant species. Early in the spring when the bays are full they appear like any other pond with emergent and floating vegetation. The same bay may appear to be grassland in late summer and fall with a completely different set of dominant species. The species composition is zonal, from open grassy swales dominated by herbaceous species near the center of the pond to forested wetlands around their perimeters. According to McAvoy and Bowman (2002) Delmarva Bays harbor 45 rare and uncommon species, eight globally rare species and the federally endangered Canby's dropwort (*Oxypolis canbyi*); the latter occurs in a single pond in Queen Anne's County. One of the more intriguing globally rare plants is the diminutive Harper's fimbriatylis (*Fimbristylis perpusilla*). This is a tiny, inconspicuous grass-like plant growing only a few inches tall that is restricted to the very center (the lowest elevation) of the ponds. It may grow thickly in the exposed muddy soil—but only in those years where the ponds are completely dry. The total habitat area for this species may be less than a half-acre with each pond contributing a few square feet! This plant ranges from Maryland south to Georgia, a typical distribution for plants of Delmarva Bays (McAvoy and Bowman 2002). On the other end of the spectrum is rose coreopsis (*Coreopsis rosea*) (Figure 9), a lovely aster-like plant that is restricted to only two ponds on the Eastern Shore.



Figure 9. Two species found in regionally endemic plant communities. (left) Rare and threatened Kate's-mountain clover, *Trifolium virginicum*, endemic to shale barrens. Photo by Christopher Frye; (right) Rare and endangered Rose coreopsis, *Coreopsis rosea*, known from two Delmarva Bays on the Eastern Shore, endemic to Bay wetlands. Photo by Wesley Knapp.

At the other extreme, Maryland contains part of the biodiversity zone known as the Mid-Appalachian Shale Barrens. These extremely dry and sun-baked barrens and woodlands contain 18 species found nowhere outside of the narrow Appalachian range from southwestern Pennsylvania, Maryland, western Virginia and adjacent West Virginia (Keener 1983). The flagship species of the shale barrens is a native clover called Kate's-mountain clover (*Trifolium virginicum*) (Figure 9). Maryland contains almost 100 populations of this species in a narrow ~18 kilometer-wide zone in Allegany and Washington Counties. The plants that live in these harsh habitats are obligate sun-lovers and are intolerant of shade. Kate's-mountain clover grows in exposed beds of shale with little to no soil development. Other species endemic to the shale barrens are the aptly-named shale barren goldenrod (*Solidago harrissii*), shale barren ragwort (*Packera antennariifolia*) and shale barren primrose (*Oenothera argillicola*). In the stream

valleys where nutrients accumulate and soil moisture is less limiting, this narrow region of Maryland contains some of the most diverse displays of native wildflowers in the state.

Continuing discovery

Summary: A surprising number of plant species are still being discovered. Although it is impossible to prove, it is a certainty that we have lost species from the State that we never knew and will never know existed. Given the threats outlined in this Report it is more critical than ever to find and protect the rare flora of the State.

In 2011 Knapp et al. reported fifteen new native additions or rediscoveries to the flora of Maryland. In 2012 and 2013 an additional 9 species have been documented. Nearly all of these discoveries are or will be treated as rare, threatened or endangered. Among these discoveries are species in groups one would think have been thoroughly explored such as orchids and tree species. Numerous recent discoveries also mark range extensions that would also be considered noteworthy from a conservation standpoint.



Figure 10. Water Pygmyweed (Crassula aquatica), presumed extirpated, recently rediscovered at Allen's Fresh Natural Area in Charles County, and now considered rare and endangered. Photo by Wesley Knapp.

Conservation of Maryland's Rare, Threatened and Endangered Plants

Regulatory authority, responsibility and resources for native plant conservation in Maryland

Summary: For historical reasons, legal protection for plants is different from that for animals. In Maryland, the Nongame and Endangered Species Conservation Act defines criteria for listing for both plant and animal species in need of conservation attention. The lead agency with this responsibility is the Wildlife and Heritage Service within DNR, which maintains a database of natural areas and occurrences of rare, threatened and endangered plant and animal species. This database is aligned with an international network (the Natural Heritage Network). Funding for conservation work on plants is largely limited to one source, the Chesapeake Bay and Endangered Species Fund, generated from state tax check-off revenue.

Because of its origins in the Teddy Roosevelt era and the nature of formative initiatives such as the Migratory Bird Treaty Act, most conservation policy and law deals with animals rather than plants. Under the North American model for conservation, various units of government were established under the Department of the Interior in order to address specific priorities: The Forest Service would provide healthy forests for the production of timber, the Park Service would take care of the parks, and the U.S. Fish and Wildlife Service would deal with fish and wildlife. Lands not managed by one of these three agencies would be under the purview of the Bureau of Land Management and Reclamation.

When the Federal Endangered Species Act became law in 1973, protection was provided to animals as populations and individuals, but not to the plant communities that comprised their habitat. Since the Act's inception, plants have been added to the federal endangered species list, but with lower standards of protection. Today most federal funding for unique species is specifically designated for animals or even for "birds and mammals" only.

Similarly, in Maryland's version of the Endangered Species Act, while wildlife are well provided with protections (from some activities), plants are effectively left to the discretion of a property owner who may destroy them under most circumstances if that is his wish. Federal and state wildlife laws in the United States have their origins in old English common law where the King and Parliament owned the wild animals and prescribed the ways that ordinary citizens could harvest them on all lands, public or private. By contrast, plants were considered to be a part of the land on which they grew and thus plants on private lands were treated as the owner's private property.

The primary State law (enacted in 1975) that allows and governs the listing of endangered species is the Nongame and Endangered Species Conservation Act (Annotated Code of Maryland 10-2A-01). The Act is supported by regulations (Code of Maryland Regulations 08.03.08) that define listing criteria for endangered, threatened and endangered extirpated species, establishes the purpose and intent of collecting permits and lists prohibited activities. Again, plants on private lands are viewed as the owner's property. In contrast, on public lands,

State agencies tasked with management of those properties are required to take into account the presence of threatened and endangered plant species during project reviews.

Maryland land planning efforts have historically accounted for sites containing protected species relatively late in the planning process, as road designs, industrial development, or subdivision plans were reviewed. The news of the presence of unique habitats or rare species generally has been an unpleasant surprise for permit applicants. Recent efforts by Maryland state government to highlight these areas, notably the ‘Green Infrastructure’ model, have made the locations of many unique natural communities available to county planning and zoning departments. In some areas, this information is being incorporated into local master plans, but county use of the data is not uniform.

The threats to Maryland’s botanical heritage, and therefore to its wildlife heritage, are not news. Recognizing this, the General Assembly and the Governor have assigned to state agencies numerous responsibilities to manage, control, and alleviate the forces that threaten our state’s biodiversity.

Since 1979, the **Wildlife and Heritage Service** (the “Service”) within DNR has been the lead state agency responsible for the identification, ranking, protection and management of rare and endangered species and natural communities in Maryland.² The Service seeks to identify and sustain populations of rare plants and animals through the maintenance of healthy natural ecosystems. The Service also reviews proposed development projects for potentially harmful effects on rare species. The Service maintains a database of natural areas and occurrences of rare, threatened and endangered plant and animal species. This database is aligned with an international network (the Natural Heritage Network) that tracks and monitors species using identical methodologies, nomenclature, and units of measure across all fifty states, Canada and Latin America. In Maryland, the Service has documented approximately 720 sites that support unique habitat for either plants or animals. Moreover, habitats that support rare animals without the support of specialized plant communities are a small component of these sites. Plant communities are generally the baseline fabric of natural communities that support both rare plants and animals.

The Service provides recommendations for the conservation of rare plant species and plant communities through its coordination and advisory role with other agencies in environmental review. Maryland Department of the Environment (MDE) and other regulatory agencies and programs provide some opportunity for rare plant and plant community conservation, though plant conservation is one of numerous considerations. The Tidal Wetlands, Nontidal Wetlands and Waterway Construction statutes and regulations, implemented by MDE, include such considerations and often require project re-design to address concerns related to protection of designated plants which are state endangered or threatened. MDE screens all project applications for the presence of rare species and coordinates with DNR on protective measures to balance these concerns with goals of applicants. Nontidal Wetland regulations also designate certain wetlands as “Nontidal Wetlands of Special State Concern,” which include wetlands of unique natural community types and rare plant species. These wetlands are surrounded by a regulated 100-foot buffer and are subject to more stringent review requirements than other nontidal wetlands.

² Direct responsibility for these functions lies with the Maryland Natural Heritage Program, a component of the Wildlife and Heritage Service.

It is critical to understand that funds for work on rare plants are largely limited to one source, the Chesapeake Bay and Endangered Species Fund, generated from state tax check-off revenues, with much smaller contributions from federal sources for federally endangered or threatened species only.

Over the years, the resources available for conservation efforts by state agencies have continually dwindled to the point where tasks that Maryland citizens would expect to be done cannot be done. Insufficient resources are available for the most basic of conservation tasks: surveying plant populations to detect and assess changes, threats and long-term trends; data collection and inventory; monitoring and managing existing plant conservation efforts; and outreach to landowners to encourage conservation on private land. This results in insufficient protection status for many plant species and populations, and inadequate protection for those species identified as in need of protection.

In some cases, the Wildlife and Heritage Service may work with other agencies within DNR, with private organizations, or with other federal funding sources to purchase properties supporting natural communities, restore natural communities that support rare plants and animals, or to fund other projects involving both rare plants and animals. By focusing energies on those plants, animals and natural areas that are most in danger of disappearing, the Service attempts to ensure that these essential elements of Maryland's diverse biological heritage do not vanish from our landscape.



Figure 11. Barrens Strawberry, Waldstenia fragarioides (foreground, yellow flowers) growing with rare and threatened Senega Snakeroot, Polygala senega (background, white flowers) in Green Ridge State Forest, Allegany County. Photo by Christopher Frye.

What it means for a plant species to be classified rare, threatened or endangered

Summary: The list of Maryland's rare, threatened and endangered (abbreviated RTE) species reflects Maryland's unique geographic position in the United States. The current RTE list comprises some 710 species, subspecies and varieties. In order to quickly relate information on the level of rarity and endangerment of species, the RTE list uses a set of shorthand metrics. These metrics communicate two basic pieces of information: (1) the conservation rank, a generalized measure of rarity; and (2) conservation status, a declaration of legal status through the familiar terms, threatened and endangered.

Conservation Ranks and Conservation Status

Conservation ranks are arranged along a simple numerical scale (1-5) with the lower numbers reflecting increasing rarity. Conservation ranks also present geographic information about rarity. State ranks (S ranks) communicate the rarity of the species in the State whereas global ranks (G ranks) communicate the rarity of the species throughout its range (although the term "global" is used, most species are far from being globally distributed). The rank of a species is determined through analyses of population number, size, viability, threats and trends among other things. The final metric, a combination of the numeric index (1-5) and the geographic identifier (G or S) distills this large amount of information into a single metric. By analogy, sports statistics don't relate everything about a player, but they provide an index so that one can visualize how a particular player compares with others. State ranks for many species are modified annually, and status is reviewed every 2-5 years or as needed.

Thus, for a particular plant species that has a global rank of G1 and a state rank of S1 the species is not only rare within Maryland but also rare within its entire range. Similarly, a plant species with ranks of G5 and S5 relate that the plant is common in Maryland and demonstrably secure in its global range. Definitions of conservation ranks are presented in Table 1. All states (and Canadian provinces) use the same ranking system and format. This allows comparisons across the political and geographic landscape and it is one of the most powerful aspects of the network of State Natural Heritage Programs.

Conservation status presents a simple hierarchy of endangerment in three, mostly familiar, categories: threatened (the lowest status), endangered (the highest status), and endangered-extirpated (a category unique to Maryland). Definitions of conservation statuses are presented in Table 2. All species listed as threatened and endangered at the federal level are also listed by individual states where the species occurs. This provides a segue into the statistics of the current Maryland RTE plant list. (For a more detailed explanation of the operation and utility of the RTE Plant List, see Appendix 3.)

Table 1. Definitions of Global (G) and State (S) Conservation Ranks. The conservation rank of a species is designated by a number from 1 to 5, preceded by a letter reflecting the appropriate geographic scale of the assessment (G = Global and S = Subnational/State or Province).

Rank	Definition
GX or SX	Presumed Extirpated —Species believed to be extirpated from the jurisdiction (i.e., nation, or state/province). Not located despite intensive searches of historical sites and other appropriate habitat, and virtually no likelihood that it will be rediscovered.
GH or SH	Possibly Extirpated —Known from only historical records but still some hope of rediscovery. There is evidence that the species may no longer be present in the jurisdiction, but not enough to state this with certainty..
G1 or S1	Highly Rare and Critically Imperiled —At very high risk of extinction or elimination due to very restricted range, very few populations or occurrences, very steep declines, very severe threats, or other factors. Typically occurring in fewer than 5 populations.
G2 or S2	Rare and Imperiled —At high risk of extinction or elimination due to restricted range, few populations or occurrences, steep declines, severe threats, or other factors. Typically occurring in 6 to 20 populations.
G3 or S3	Rare to Uncommon and Vulnerable —At moderate risk of extinction or elimination due to a fairly restricted range, relatively few populations or occurrences, recent and widespread declines, threats, or other factors. Typically occurring in 21-80 populations.
G4 or S4	Apparently Secure —At fairly low risk of extinction or elimination due to an extensive range and/or many populations or occurrences, but with possible cause for some concern as a result of local recent declines, threats, or other factors.
G5 or S5	Secure —At very low risk of extinction or elimination due to a very extensive range, abundant populations or occurrences, and little to no concern from declines or threats.

Table 2. Definitions of State and Federal Status.

State Status	Definition
Endangered (E)	A species whose continued existence as a viable component of the State’s flora is determined to be in jeopardy.
Threatened (T)	A species that appears likely within the foreseeable future to become endangered in the State.
Endangered-Extirpated (X)	A species that was once a viable component of the flora of the State but for which no naturally occurring populations are known to exist.
Federal Status	Definition
Endangered (LE)	Listed as endangered under the federal Endangered Species Act; in danger of extinction throughout all or a significant portion of their range.
Threatened (LT)	Listed as threatened under the federal Endangered Species Act; likely to become endangered within the foreseeable future throughout all or a significant portion of their range.

What can be learned from lists of rare, threatened and endangered plants

SUMMARY: Nearly 28% of Maryland’s flora—710 species—are rare, threatened, endangered or extirpated (RTE). Of these, 343 are classified as rare, meaning that they occur in fewer than 5 populations, and 48 are considered historical or extirpated. DNR’s Wildlife and Heritage Service is solely responsible for the listing, management and recovery of all RTE species. This is a significant challenge, especially considering that these species are scattered across Maryland in hundreds of individual sites and populations.

A breakdown of the Maryland flora according to both rank and status is presented in Figure 12. From this figure we see that the largest wedge in the pie presents the good news: 72% of the Maryland flora isn’t rare. **The bad news is that nearly 28% of the Maryland flora is rare, threatened, endangered, or endangered-extirpated.**

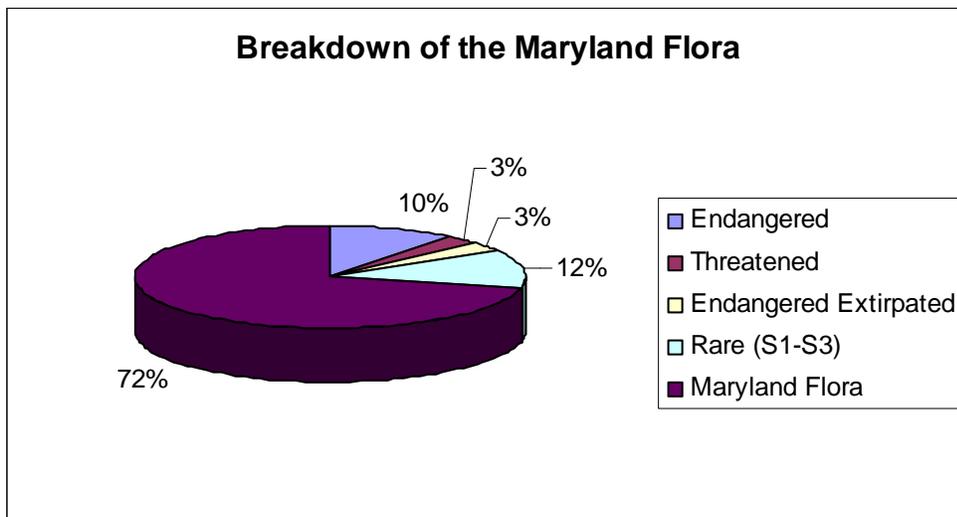


Figure 12. Breakdown of the Maryland Flora by Rank and Status. (Based upon an estimate of 2500 vascular plants in the Flora).

Twenty-eight percent represents 710 species. This number is striking. Consider that DNR’s Wildlife and Heritage Service is solely responsible for the listing, management and recovery of all RTE species. The challenges in dealing with so many species become evident. Further, these species are scattered across Maryland in hundreds of individual sites and populations, presenting logistical challenges for the small staff of the Service’s Natural Heritage Program.

Figure 13 presents the breakdown of ranks for Maryland’s 710 rare plants. The largest category is S1 (47%), meaning that about 343 species occur in fewer than 5 populations! Roughly 17% of the rare plants occur in fewer than 21 populations (S2) and 22% are considered vulnerable (S3). An astounding 14% of the rare plants are considered either historical (SH, 13%) or are considered extirpated (SX, 1%).

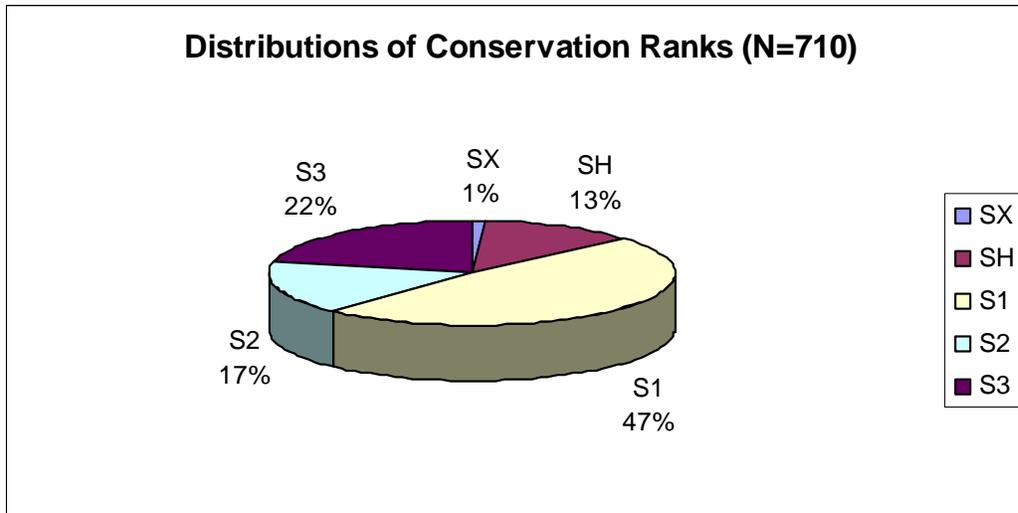


Figure13. Distribution of Conservation Ranks for Maryland's Rare Plants.

To illustrate some of the logistical and management challenges consider the following example of an S1 species:

Castilleja coccinea (L.) Spreng. Indian-paintbrush G5 S1 Endangered
 Orobanchaceae (Broomrape Family)
 Conservation note: Critically endangered due to habitat loss. Reduced to small, isolated fragments of habitat.
 Allegheny Plateau, Piedmont, Ridge and Valley* (physiographic areas): mafic fens, meadows, and occasionally roadsides (Carroll, Cecil*, Frederick*, Garrett).

Indian-paintbrush is listed as endangered because of habitat loss and from this example we understand that each population is likely small, occurring in small and isolated fragments of prairie-like habitat from Carroll County west to Garrett County (extant) but occurred historically (indicated by asterisks) from Cecil and Frederick Counties. Management at these locations requires many activities including managed grazing, invasive species control, and annual mowing as well as general monitoring of the populations (stem counts, flowering and seed production, etc.). For the present time, the Wildlife and Heritage Service is rarely able to undertake such activities due to lack of resources. Rather, the Service goes through a process of triage, taking those species in critical need first.

The additional bad news is that some species will always be endangered or threatened, that is, recovery is not possible because either we do not understand the reasons for population declines (that may be related to ecosystem function) or the habitat is so specific and so reduced that the population occurs only at one or a few stations.

This is a dismal assessment but it is made from a particular frame of reference; chiefly that specific plant conservation projects are difficult if not impossible to fund under the prevailing wildlife-centric budget. Thus, plant conservation proceeds with individual efforts, but with a botanically oriented staff of 6, most of whom perform many other functions. Efforts dedicated to plant conservation are necessarily limited.

However, there are species for which conservation efforts have proven not only efficacious but have resulted in population growth. For example, restoration of serpentine grassland and savanna at Soldier's Delight has resulted in a stable population of the federally endangered sandplain



Figure 14. Rare and endangered sandplain gerardia, *Agalinis acuta*, is a singular disjunct species found at Soldiers Delight Natural Environmental Area. Conservation efforts have been successful, resulting in population growth. Photo by Wayne Tyndall.

gerardia (*Agalinis acuta*) that is the largest population in the United States. Restoration of bog turtle wetlands in the Maryland Piedmont has stabilized an otherwise declining population of Canada burnet (*Sanguisorba canadensis*). Woody plant management at an inland sand ridge site has resulted in the State's largest population of sundial lupine (*Lupinus perennis*) as well as the largest, most viable population of a globally rare butterfly, the Frosted Elfin (*Calophrys irus*), an obligate associate of lupine (host plant).

Conclusions concerning ongoing conservation of Maryland's rare, threatened and endangered plants

Summary: The situation is dire for many of Maryland's plant species. At current funding and staffing levels, the Wildlife and Heritage Service struggles to accomplish the most basic tasks of monitoring and record keeping, and is able only occasionally to conduct conservation projects in the field. Moreover, the infrastructure needed to support plant conservation—herbaria (collections of preserved plant specimens), and botanical/ecological research—is crumbling. The Work Group's recommendations do not aspire to the ideal, but attempt to take the reality of budget limitations into consideration.

We conclude that at the current level of support we will be unable to halt the movement of many species from rare to threatened to endangered simply for lack of adequate funding—a point made clear almost two decades ago by Schemske et al. (1994) and more recently by Stein and Gravuer (2008). These losses will occur as a result of increasing urbanization, resulting in direct habitat conversion (immediate loss due to development), but also as a result of habitat fragmentation, competition and displacement by invasive species, and herbivory by white-tailed deer (longer-term losses). Other forms of loss, particularly the losses of individual populations where already rare species become numerically rarer, will also occur. Clearly loss of individual populations will occur due to direct development pressures but also and significantly because population-level processes of reproduction and recruitment will be altered. Detecting and mitigating these losses requires the kinds of monitoring and management that we usually are not able to perform.

In addition, the Work Group is deeply concerned about two extrinsic factors unrelated to actual species and population losses but nevertheless impacting our ability to perform conservation work. The first factor regards the disappearance of biodiversity collections (herbaria). Natural history collections have long been indispensable resources for studies of biodiversity, and the need to maintain them has recently taken on greater urgency. These collections offer a unique

perspective, providing data over a long time span. They are essential for the study of habitat loss and fragmentation, biological invasions, and the consequences of global climate change. Maryland's biodiversity collections that allow long-term analyses of botanical trends (including the DNA archived in those collections) seem to be perpetually under threat of dismantlement. Where collections have been maintained, they are maintained on a starvation diet of funding allowing little other than general maintenance. Much has been written about the values of those collections (Suarez and Tsutsui 2004).

The second factor regards the attrition of botanical capacity in our state universities and resource management agencies (Kramer et al. 2010). The outcome likely will be that new generations of conservation biologists are discouraged from entering botany because of the lack of research funding. Certainly, without specific plant conservation funds, DNR is unable to support undergraduate and graduate research—no matter how integral the research questions might be to management or recovery of the species. Despite these limitations, DNR botanists work closely and collaboratively with faculty and staff of Maryland universities but those relationships and the work performed are often based upon a spirit of volunteerism and on shoestring budgets.

Declining revenues in State budgets appear likely to continue. Our recommendations reflect what we believe can be accomplished with existing resources, as well as with modestly enhanced funding or staff support. We recommend a thorough reevaluation of conservation priorities. Those priorities and our overall strategies are presented in following sections.