National Park Service
U.S. Department of the Interior

Northeast Region
Philadelphia, Pennsylvania

Classification and Mapping of Vegetation and Fire Fuel Models at Delaware Water Gap National Recreation Area: Volume 2 of 2 – Appendix G

Technical Report NPS/NER/NRTR—2007/076

ON THE COVER
Hickory - Eastern Red-cedar Rocky Woodland, near Milford, Pennsylvania in the Delaware Water Gap National Recreation Area.
Photograph by: Gregory Podniesinski.

Classification and Mapping of Vegetation and Fire Fuel Models at Delaware Water Gap National Recreation Area: Volume 2 of 2 – Appendix G

Technical Report NPS/NER/NRTR—2007/076

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U.S. Department of the Interior
National Park Service
Northeast Region
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KEY TO VEGETATION ASSOCIATIONS IN DELAWARE WATER GAP NATIONAL RECREATION AREA

1. Area is predominantly bare rock outcrops, boulders, talus, scree, cobbles, gravel, sand, or bare leaf litter with scattered vegetation covering less than 25% of total area. These areas are often on extremely steep slopes, cliffs, ridgetops, or along the Delaware River shoreline.
SPARSE VEGETATION GROUP

1. Area is not predominantly bare rock outcrops, boulders, talus or scree. Vegetation covers 25% or more of the area.

    2. Association is dominated by herbaceous or graminoid species. Woody species cover less than 25% of the area. (Small patch herbaceous seeps or vernal pools that may occur under closed or partially closed forest canopy are included here).
    HERBACEOUS GROUP

    2. Woody species (shrubs or trees) cover at least 25% of the area.

        3. Shrubs (woody species 5 meters tall or less) cover at least 25% of the area. Trees (woody species greater than 5 meters tall) cover less than 25% of the area.
        SHRUB GROUP

        3. Trees (woody species greater than 5 meters tall) cover at least 25% of the area.

            4. Trees (woody species greater than 5 meters tall) cover 25–60% of the area.
            WOODLAND GROUP

            4. Trees (woody species greater than 5 meters tall) greater than 60% of the area.
            FOREST GROUP

SPARSE VEGETATION GROUP

1. Sparse vegetation occurs on cobble, gravel, or sand bars adjacent to the Delaware River.
Riverine Scour Vegetation

1. Sparse vegetation does not occur on cobble, gravel, or sand bars adjacent to the Delaware River.

    2. Ground is concave, a shallow basin or depression that holds standing water for at least part of the year. The bottom of the shallow basin may be lined with leaf litter or large boulders.

        3. The bottom of the depression is lined with leaf litter.
Eastern Woodland Vernal Pool Sparse Vegetation

        3. The bottom of the depression is lined with large boulders. These depression occur on the top of Kittantinny Ridge.
Boulder Vernal Pool Sparse Vegetation

    2. Either, the ground is convex and occurs on ridgetop or the crests of steep slopes with a substrate of large rock outcrops; OR the ground is steeply sloping with a substrate of loose weathered shale scree, rock cliffs, or large talus boulders. The area does NOT hold standing water for part of the year.

        4. Area is steeply sloping, at upper, middle or lower slope topographic positions. Substrate is composed of loose weathered shale scree, rock cliffs, or large talus boulders.

            5. Sparse variable vegetation established in crevices of steep, often southeast-facing sandstone or shale cliffs. Substrate not talus boulders, shale scree, or ridgetop rock outcrops.
Sparsely Vegetated Cliff

            5. Substrate is talus boulders or shale scree.

                6. Sparse variable vegetation established in crevices between large boulders that cover the ground (i.e., boulderfields). Occurs on very steep, typically southeast-facing lower slopes of the Kittatiny Ridge.
Sandstone Talus

                6. Association occurs on very steep, southeast-facing lower slopes covered in gravelly shale scree along the eastern edge of the plateau in Pennsylvania. Vegetation is variable and can be absent or sparse.
Shale Scree Slope

4. Area occurs on ridgetop or the crests of steep slopes. Substrate is large rock outcrops. Substrate is not loose weathered shale scree, rock cliffs, or large talus boulders.

    7. Trees and shrubs cover less than 10% of the area. Prominent vegetation includes herbaceous and graminoid species growing in crevices and in thin soil over bedrock. Characteristic species include wavy hairgrass (*Deschampsia flexuosa*), common sheep sorrel (*Rumex acetosella*), eastern hayscented fern (*Dennstaedtia punctilobula*), poverty oatgrass (*Danthonia spicata*), little bluestem (*Schizachyrium scoparium*), and tapered rosette grass (*Dichanthelium acuminatum* var. *acuminatum*).

        Wavy Hairgrass - Common Sheep Sorrel Rock Outcrop

    7. Trees and shrubs cover 10–25% of the area.

        8. Association occurs on rocky summits and ridgetops, often with northern or western aspect. Slope generally less than 25 %.

            Pitch Pine - Mixed Hardwood Rocky Summit

        8. Association occurs among rock outcrops on upper slopes, on the tops of cliffs along Kittatinny Ridge, or along narrow shelves on very steep southeast-facing cliffs in Pennsylvania. Aspect is generally to south to southeast with a slope greater than 25% (often greater than 50%).

            Hickory - Eastern Red-cedar Rocky Woodland

HERBACEOUS GROUP

1. Riparian vegetation that occurs in the floodplain of the Delaware River on islands, shorelines, gravel/cobble bars, or riverbeds. Vegetation structure and composition are influenced by river flooding and scour.

    2. Association is dominated (relative cover >50%) by either American water-willow (*Justicia americana*) or Japanese knotweed (*Polygonum cuspidatum*).

        3. Association is dominated by American water-willow (*Justicia americana*), forming emergent beds at the heads of islands or adjacent to bars and shorelines.
        Water-willow Emergent Bed

        3. Association is dominated by Japanese knotweed (*Polygonum cuspidatum*), establishing on islands and shorelines.
        Japanese Knotweed Herbaceous Vegetation

    2. Association is not dominated (relative cover <50%) of American water-willow (*Justicia americana*) or Japanese knotweed (*Polygonum cuspidatum*).

        4. Vegetation established on limestone outcrops or large fractured limestone cobbles along the New Jersey shoreline of the Delaware River.

            5. Association is characterized by open, sparsely vegetated sections of smooth Onondaga limestone outcrops with north-northwest exposure. Typical vegetation is a mixture of riparian species, xeric-loving crevice plants, and rare calciphiles.
            Calcareous Riverside Outcrop

            5. Association occurs on alluvial deposits combined with fractured limestone substrate. Seeps occur where groundwater flows out and over the cobbled substrate. Vegetation can be dense, robust, and diverse, supporting many grasses, sedges and rare calciphiles.
            Calcareous Riverside Seep

        4. Vegetation not associated with limestone outcrops or large fractured limestone cobbles along the New Jersey shoreline of the Delaware River.

            6. Vegetation dominated by reed canarygrass (*Phalaris arundinacea*) or hairyfruit sedge (*Carex trichocarpa*).

                7. Vegetation dominated by reed canarygrass (*Phalaris arundinacea*) that has greater than 50% cover.
                Reed Canarygrass Riverine Grassland

                7. Vegetation dominated by hairyfruit sedge (*Carex trichocarpa*) that has greater than 50% cover.

Hairyfruit Sedge Wetland

6. Reed canarygrass (*Phalaris arundinacea*) and hairyfruit sedge (*Carex trichocarpa*) are absent or constitute less than 50% relative cover.

    8. Vegetation resembles tall prairie-like grassland (in summer and early fall) dominated by big bluestem (*Andropogon gerardii*), Indiangrass (*Sorghastrum nutans*), switchgrass (*Panicum virgatum*) and little bluestem (*Schizachyrium scoparium*). Association occurs on sand/gravel deposits along shorelines and on islands.

Big Bluestem - Indiangrass Riverine Grassland

    8. Variable vegetation in and directly adjacent to the active channel that is underwater for a significant portion of the year and is exposed during periods of low water (typically mid summer to early fall except during flood events). Frequent scour causes variation in species composition that is characteristic of this community. Cobbles and sand on island heads, bars, spits, low terraces, and shorelines support this vegetation type.

Riverine Scour Vegetation

1. Palustrine or terrestrial vegetation that is not directly associated with the Delaware River. Palustrine vegetation associated with creeks and tributaries to the Delaware River is included here.

    9. Palustrine vegetation with standing water, saturated soil, or groundwater seepage for at least a portion of the growing season.

        10. Association occurs as a small patch community directly associated with groundwater seepage, often over calcareous bedrock.

            11. Wetland occurs over calcareous bedrock and may contain calciphilic plant species.

                12. Typical species include New York ironweed (*Vernonia noveboracensis*), eastern marsh fern (*Thelypteris palustris*), violets (*Viola* spp.), golden ragwort (*Packera aurea*), skunk-cabbage (*Symplocarpus foetidus*), Jack in the pulpit (*Arisaema triphyllum*), American marshpennywort (*Hydrocotyle americana*), thoroughwort (*Eupatorium* spp.), touch-me-not (*Impatiens* spp.), whorled mountainmint (*Pycnanthemum verticillatum*), American hogpeanut (*Amphicarpaea bracteata*), twoleaf miterwort (*Mitella diphylla*), white turtlehead (*Chelone glabra*), white edge sedge (*Carex debilis*), Japanese stiltgrass (*Microstegium vimineum*), and rice cutgrass (*Leersia oryzoides*). Does not contain the characteristic fen indicators listed below for Calcareous Fen.

Calcareous Seep

12. Wetland contains some of the following characteristic fen indicator species: fen grass-of-Parnassus (*Parnassia glauca*), Ontario lobelia (*Lobelia kalmii*), downy willowherb (*Epilobium strictum*), rigid sedge (*Carex tetanica*), smallhead rush (*Juncus brachycephalus*), and purple avens (*Geum rivale*). Common species include golden ragwort (*Packera aurea*), eastern marsh fern (*Thelypteris palustris*), narrowleaf mountainmint (*Pycnanthemum tenuifolium*), sensitive fern (*Onoclea sensibilis*), woodland rush (*Juncus subcaudatus*), wrinkleleaf goldenrod, (*Solidago rugosa*), tussock sedge (*Carex stricta*), crested woodfern (*Dryopteris cristata*), and Dudley's rush (*Juncus dudleyi*).

Calcareous Fen

11. Wetland occurs on acidic sandstone, siltstone, shale or slate bedrock. Characteristic vegetation includes tufted hairgrass (*Deschampsia cespitosa*), downy goldenrod (*Solidago puberula*), Boreal chickweed (*Cerastium biebersteinii*), and Hammond's claytonia (*Claytonia virginica* var. *hammondiae*).

Acidic Seep

10. Association not limited to areas with groundwater seepage. Vegetation is typically flooded at least in the early portion of the growing season.

13. Vegetation occurs adjacent to creeks and tributaries. Vegetation dominated by reed canarygrass (*Phalaris arundinacea*) or hairyfruit sedge (*Carex trichocarpa*).

14. Vegetation dominated by reed canary grass (*Phalaris arundinacea*) that has greater than 50% cover.

Reed Canarygrass Riverine Grassland

14. Vegetation dominated by hairyfruit sedge (*Carex trichocarpa*) that has greater than 50% cover.

Hairyfruit Sedge Wetland

13. Vegetation is not associated with creeks and tributaries. Reed canarygrass (*Phalaris arundinacea*) and hairyfruit sedge (*Carex trichocarpa*) are absent or constitute less than 50% relative cover.

15. Wetland contains standing water for most or all of the year and is often associated with impounded drainages, ponded areas near streams, or saturated areas surrounding drainages.

16. Dominant species is tussock sedge (*Carex stricta*) covering 30-75% of the area.

Tussock Sedge Marsh

16. Tussock sedge (*Carex stricta*) covers less than 30% of the wetland. Vegetation is dominated species that are tolerant of standing water, although species composition is variable.

    17. Cattails (*Typha* spp.) are the clear dominant in the wetland, covering greater than 50% relative cover.

    Cattail Marsh

    17. Cattails (*Typha* spp.) are not the clear dominant. Species composition can be variable. Common species include: needle spikerush (*Eleocharis acicularis*), swamp verbena (*Verbena hastata*), nodding beggartick (*Bidens cernua*), rice cutgrass (*Leersia oryzoides*), marshpepper knotweed (*Polygonum hydropiper*), arrowleaf tearthumb (*Polygonum sagittatum*), field horsetail (*Equisetum arvense*), New England aster (*Aster novae-angliae*), owlfruit sedge (*Carex stipata*), and/or marsh seedbox (*Ludwigia palustris*).

    Mixed Forb Marsh

15. Wetland is typically flooded in early growing season and is dry or saturated the rest of the year.

    18. Vegetation is typically thick (>75% absolute cover). Typical species include a diverse mix of hydrophilic graminoids such as sedges (*Carex* spp.), bulrushes (*Scirpus* spp.), rushes (*Juncus* spp.), rice cutgrass (*Leersia oryzoides*), and rough bentgrass (*Agrostis scabra*). Associated herbs include arrowleaf tearthumb (*Polygonum sagittatum*), eastern marsh fern (*Thelypteris palustris*), and giant goldenrod (*Solidago gigantea*).

    Wet Meadow

    18. Vegetation is typically sparse (0–50% absolute cover) and occurs in a small depression that is seasonally flooded and lined with leaf litter.

    Eastern Woodland Vernal Pool Sparse Vegetation

9. Terrestrial vegetation with no standing water, saturated soils, or groundwater seepage.

    19. Vegetation occurs on bedrock outcrops or thin soils and covers less than 50% of the area. Wavy hairgrass (*Deschampsia flexuosa*), common sheep sorrel (*Rumex acetosella*), and poverty oatgrass (*Danthonia spicata*) are characteristic species.

    Wavy Hairgrass - Common Sheep Sorrel Rock Outcrop

    19. Vegetation is dense (>80% cover), not dominated by wavy hairgrass (*Deschampsia flexuosa*), and is not associated with bedrock outcrops.

        20. Little bluestem (*Schizachyrium scoparium*) covers greater than 50% of the area.

        Little Bluestem Grassland

20. Little bluestem (*Schizachyrium scoparium*) covers less than 50% of the area. Characteristically dominant species are wrinkleleaf goldenrod (*Solidago rugosa*) and sweet vernalgrass (*Anthoxanthm odoratum*) with numerous other graminoid and herbaceous associates.

Old Field

SHRUB GROUP

1. Riparian vegetation that occurs in the floodplain of the Delaware River on islands, shorelines, gravel/cobble bars, or riverbeds. Vegetation structure and composition are influenced by river flooding and scour.

    2. Vegetation is characterized by a moderately dense to dense short shrub layer less than 2 m in height. Characteristic species include willows (*Salix nigra, Salix eriocephala, Salix sericea*) and sycamore (*Platanus occidentalis*). Tall shrubs (2-5 m in height) cover less than 25% of the area.

    Sycamore (Willow) - Mixed Hardwood Riverine Dwarf Shrubland

    2. Vegetation is characterized by a moderately dense to dense tall shrub layer of shrubs 2–5 m in height that cover greater than 25% of the area. Dominant species is typically sycamore (*Platanus occidentalis*), with associates river birch (*Betula nigra*), black willow (*Salix nigra*), and silver maple (*Acer saccharinum*).

    Sycamore - Mixed Hardwood Riverine Shrubland

1. Palustrine or terrestrial vegetation that is not directly associated with the Delaware River. Palustrine vegetation associated with creeks and tributaries to the Delaware River is included here.

    3. Palustrine vegetation with standing water, saturated soil or groundwater seepage for at least a portion of the growing season.

        4. Association is dominated or co-dominated by thick layer of leatherleaf (*Chamaedaphne calyculata*) that covers 50% or more of the wetland.

            5. Cover of highbush blueberry (*Vaccinium corymbosum*) and other tall shrubs is <50% of the wetland. A stunted dense layer of leatherleaf (*Chamaedaphne calyculata*) is prominent. Common "bog" plants such as purple pitcherplant (*Sarracenia purpurea*), roundleaf sundew (*Drosera rotundifolia*), swamp loosestrife (*Decodon verticillatus*), and white beaksedge (*Rhynchospora alba*) are typically growing on a thick sphagnum moss (*Sphagnum* sp.) mat.

            Leatherleaf Peatland

            5. Highbush blueberry (*Vaccinium corymbosum*) and other tall shrubs cover 50% or more of the wetland. A stunted dense layer of leatherleaf (*Chamaedaphne calyculata*) is prominent under the tall shrubs. The "bog" plants listed above are not common.

            Highbush Blueberry - Leatherleaf Wetland

        4. Leatherleaf (*Chamaedaphne calyculata*) is absent or a minor component of the wetland (cover < 50%).

6. Association occurs as a small patch community that contains calciphilic plants and is directly associated with groundwater seepage from calcareous bedrock. Shrubby cinquefoil (*Dasiphora floribunda*) and poison sumac (*Toxicodendron vernix*) are often present and may be abundant.

    7. Wetland contains active precipitation of marl deposits and the alga Chara (*Chara* spp.).

    Marl Fen

    7. Wetland does not contain active precipitation of marl deposits or the alga Chara (*Chara* spp.).

    Calcareous Fen

6. Association not limited to areas with groundwater seepage and does not contain calciphilic plants. Shrubby cinquefoil (*Dasiphora floribunda*) and poison sumac (*Toxicodendron vernix*) are absent. Area contains standing water in at least the early portion of the growing season or is associated with floodplains of creeks and drainages.

    8. Wetland is dominated by common buttonbush (*Cephalanthus occidentalis*) or alders (*Alnus* spp.).

        9. Vegetation is dominated by common buttonbush (*Cephalanthus occidentalis*). Wetland experiences prolonged or semi-permanent flooding and contains sparse herbaceous vegetation.

        Buttonbush Wetland

        9. Vegetation is dominated by smooth alder (*Alnus serrulata*) or mountain alder (*Alnus incana*). Tussock sedge (*Carex stricta*) is typically dominant (>50% cover) in the herbaceous layer.

        Alder Wetland

    8. Wetland is dominated by silky dogwood (*Cornus amomum*), multiflora rose (*Rosa multiflora*), highbush blueberry (*Vaccinium corymbosum*), and/or steeplebush (*Spiraea tomentosa*).

        10. Vegetation is dominated by silky dogwood (*Cornus amomum*), crack willow (*Salix fragilis*), Morrow's honeysuckle (*Lonicera morrowii*), and/or multiflora rose (*Rosa multiflora*) within a matrix of graminoids similar to those in a Wet Meadow or Reed Canarygrass Riverine Grassland. Wetland typically occurs on the floodplain of a creek or near a drainageway.

        Silky Dogwood Successional Palustrine Shrubland

10. Vegetation is dominated by highbush blueberry (*Vaccinium corymbosum*) and/or steeplebush (*Spiraea tomentosa*). Wetland occurs in a small upland depression or a basin surrounding a small streams.

Highbush Blueberry - Steeplebush Wetland

3. Terrestrial vegetation with no standing water, saturated soils, or groundwater seepage.

11. Shrubland typically occurs at mid to low elevations on former agricultural land. Characteristic shrubs are autumn-olive (*Elaeagnus umbellata*), gray dogwood (*Cornus racemosa*), multiflora rose (*Rosa multiflora*), eastern red cedar (*Juniperus virginiana*), eastern white pine (*Pinus strobus*), flowering dogwood (*Cornus florida*), Morrow's honeysuckle (*Lonicera morrowii*), smooth sumac (*Rhus glabra*), blackhaw (*Viburnum prunifolium*), and raspberries (*Rubus allegheniensis*, *Rubus phoenicolasius*, *Rubus occidentalis*). Herbaceous vegetation is typical of Old Field Vegetation.

Successional Shrubland

11. Shrubland is restricted to rocky soil at high elevations of the Kittatinny Ridge or the plateau in Pennsylvania. Associations typically occur above 200 meters elevation in New Jersey and above 150 meters in elevation in Pennsylvania. In general, the influential factors in vegetation structure and composition are harsh edaphic conditions and fire regimes. Characteristic shrubs include bear oak (*Quercus ilicifolia*), lowbush blueberry (*Vaccinium angustifolium*), Blue Ridge blueberry (*Vaccinium pallidum*), deerberry (*Vaccinium stamineum*), black huckleberry (*Gaylussacia baccata*), sheep laurel (*Kalmia angustifolium*), mountain laurel (*Kalmia latifolia*) and eastern red cedar (*Juniperus virginiana*).

12. Shrubland occurs on cliffs, the crests of cliffs, bouldery outcrops, or steeply sloping bedrock outcrops. Bare rock can cover a significant portion of the area. Scattered stunted trees of eastern red-cedar (*Juniperus virginiana*), pignut hickory (*Carya glabra*), or pitch pine (*Pinus rigida*) are present.

13. Vegetation occurs on cliffs, the crests of cliffs, or steeply sloping bedrock outcrops. Aspect is generally to south to southeast with a slope greater than 25% (often greater than 50%). The sparse stunted shrubland is characterized by eastern red-cedar (*Juniperus virginiana*), pignut hickory (*Carya glabra*), and chestnut oak (*Quercus prinus*).

Hickory - Eastern Red-cedar Rocky Woodland

13. Vegetation occurs on bouldery ridgetop outcrops or steeply sloping bedrock outcrops. Aspect is variable. The sparse stunted trees are typically pitch pine (*Pinus rigida*) with occasional hardwood associates.

Pitch Pine - Mixed Hardwood Rocky Summit

12. Shrubland occurs at high elevations, but not on cliffs, bouldery outcrops or steep rocky slopes. Bare rock outcrops may be scattered, but do not cover a significant portion of the area. Trees are rare or absent.

    14. In general, ericaceous shrub layer covers 80-100% of the area, while grasses and forbs cover <5% of the area. Huckleberry (*Gaylussacia baccata*) and blueberries (*Vaccinium* spp.) are typically the dominant heath species, with bear oak (*Quercus ilicifolia*) as a common tall shrub associate. Association is created and maintained by fire.

    Successional Bear Oak - Heath Shrubland

    14. In general, ericaceous shrubs and bear oak (*Quercus ilicifolia*) cover 25-75% of the area, interspersed with graminoids that cover 40-70% of the area. Bear oak (*Quercus ilicifolia*) is often the dominant shrub species, with heath species such as black huckleberry (*Gaylussacia baccata*) and blueberries (*Vaccinium* spp.) as associates. Common graminoids include wavy hairgrass (*Deschampsia flexuosa*), Pennsylvania sedge (*Carex pensylvanica*), and little bluestem (*Schizachyrium scoparium*). Association is influenced by thin soils over acidic bedrock, with fire as a secondary influence.

    Bear Oak - Wavy Hairgrass Shrubland

WOODLAND GROUP

1. Riparian or palustrine vegetation that contains saturated soil for at least part of the growing season or that occurs in the floodplain of the Delaware River, its major tributaries, or smaller drainages.

    2. Canopy is dominated by silver maple (*Acer saccharinum*) or black walnut (*Juglans nigra*).

        3. Canopy is dominated by silver maple (*Acer saccharinum*), often with a dense layer of reed canarygrass (*Phalaris arundinacea*) beneath.

        Silver Maple Floodplain Forest

        3. Canopy is dominated by black walnut (*Juglans nigra*), often with a dense layer of Japanese stilt grass (*Microstegium vimineum*) beneath.

        Black Walnut Bottomland Forest

    2. Canopy is dominated by red maple (*Acer rubrum*).

        4. Palustrine woodland that occurs above 150 meters elevation in New Jersey (currently only known from NJ). Open canopy is dominated by red maple (*Acer rubrum*) and blackgum (*Nyssa sylvatica*), over a thick tall shub layer of highbush blueberry (*Vaccinium corymbosum*) or great laurel (*Rhododendron maximum*). Associates distinctive to this association include yellow birch (*Betula alleghaniensis*), eastern hemlock (*Tsuga canadensis*), pitch pine (*Prinus rigida*), and black spruce (*Picea mariana*) in the canopy; and catberry (*Nemopanthus murcronatus*), and leatherleaf (*Chamaedaphne calyculata*) in the shrub layer. Common groundstory species include prickly bog sedge (*Carex atlantica* ssp. *capillacea*), northern long sedge (*Carex folliculata*), roundleaf sundew (*Drosera rotundifolia*), water arum (*Calla palustre*), threeleaf goldthread (*Coptis trifolia*).

        Red Maple - Black Spruce - Highbush Blueberry Palustrine Woodland

        4. Palustrine woodland does not contain the distinctive associates listed above.

            5. Woodland contains highbush blueberry (*Vaccinium corymbosum*) in the tall shrub layer (15-50% absolute cover). This association is often semi-permenantly or permenantly flooded.

            Red Maple - Highbush Blueberry Palustrine Forest

            5. Highbush blueberry (*Vaccinium corymbosum*) is sparse or absent (<15% absolute cover). Red maple (*Acer rubrum*) is the canopy dominant (25-95% relative cover) with a variety of associates. This association can be temporarily to permenantly flooded.

            Red Maple Palustrine Forest

1. Terrestrial forests that do not regularly experience saturated soils during the growing season or occur on the floodplain of river, creeks, or drainages.

    6. Vegetation is restricted to rocky and thin soils, often above 200 meters elevation in New Jersey and above 150 meters in elevation in Pennsylvania. Also includes rocky summits, rock outcrops, scree slopes, and talus slopes. In general, the influential factors in vegetation structure and composition are harsh edaphic conditions and fire regimes.

        7. Woodland occurs on very steep, often southeast-facing cliffs or scree, on gently to steeply sloping large bedrock outcrops, or on rocky summits.

            8. Woodland occurs on steep shale scree, typically at mid- to lower slopes in Pennsylvania. Typical trees include eastern white pine (*Pinus strobus*), gray birch (*Betula populifolia*), and tree of heaven (*Ailanthus altissima*).

                Shale Scree Slope

            8. Woodland occurs on cliffs, gently to steeply sloping large bedrock outcrops, or rocky summits in Pennsylvania or New Jersey.

                9. Woodland occurs among rock outcrops on upper slopes or on the crests of cliffs along Kittatinny Ridge. Aspect is generally to south to southeast with a slope greater than 25% (often greater than 50%). Characteristic trees include pignut hickory (*Carya glabra*), eastern red-cedar (*Juniperus virginiana*), pitch pine (*Pinus rigida*), and chestnut oak (*Quercus prinus*).

                Hickory - Eastern Red-cedar Rocky Woodland

                9. Woodland occurs on gently to moderately steep sloping (slope <25%) rock outcrops and rocky summits. Characteristic trees include pitch pine (*Pinus rigida*), pignut hickory (*Carya glabra*), chestnut oak (*Quercus prinus*), and sweet birch (*Betula lenta*).

                Pitch Pine - Mixed Hardwood Rocky Summit

        7. Woodland does not occur on very steep, often southeast-facing cliffs or scree, on gently to steeply sloping large bedrock outcrops, or on rocky summits.

            10. Woodland contains a thick layer of shrubs (often ericaceous) that cover greater than 40% of the area. Typical shrub species include lowbush blueberry (*Vaccinium angustifolium*), Blue Ridge blueberry (*Vaccinium pallidum*), deerberry (*Vaccinium stamineum*), black huckleberry (*Gaylussacia baccata*), sheep laurel (*Kalmia angustifolium*), mountain laurel (*Kalmia latifolia*), and bear oak (*Quercus ilicifolia*).

11. Open canopy consists of scattered established trees with diameters at breast height typically >20 cm. Tyipcal tree species are: oaks (*Quercus prinus, Quercus coccinea, Quercus rubra, Quercus alba, Quercus velutina*), blackgum (*Nyssa sylvatica*), eastern white pine (*Pinus strobus*), sweet birch (*Betula lenta*), pignut hickory (*Carya glabra*) and/or pitch pine (*Pinus rigida*).
Dry Oak - Heath Forest

11. Open canopy consists of newly established trees with diameters at breast height typically <20 cm. Common species include quaking aspen (*Populus tremuloides*), bigtooth aspen (*Populus grandidentata*), gray birch (*Betula populifolia*), sweet birch (*Betula lenta*), and black cherry (*Prunus serotina*).
Successional Heath Shrubland

10. Woodland does not contain a thick layer of typically ericaceous shrubs that cover greater than 40% of the area.

12. Ridgetop woodland is dominated or co-dominated by hickories (*Carya* spp.) that cover >25% of the canopy. Frequent on upper slopes of the southeast face of Kittatiny Ridge. Occasional as small patch in other sections of the Ridge.
Dry Hickory Ridgetop Forest

12. Woodland dominated by oaks (*Quercus* spp.) and/or pines (*Pinus* spp.)

13. Eastern white pine (*Pinus strobus*) and/or pitch pine (*Pinus rigida*) constitute greater than 25% relative cover in the canopy and subcanopy combined. Dry oaks (*Quercus prinus, Quercus rubra, Quercus velutina, Quercus alba, Quercus coccinea*) are the canopy associates. The stands often contain a thick layer of regenerating pine in the tall shrub layer.
Dry Eastern White Pine - Oak Forest

13. Eastern white pine (*Pinus strobus*) and/or pitch pine (*Pinus rigida*) constitute less than 25% relative cover in the canopy and subcanopy combined.

14. Woodland occurs on coarse, bouldery sandstone talus, either on the rocky steep southeast-facing slope of the Kittatiny Ridge or on occasional boulderfields in other sections of the park. Chestnut oak (*Quercus prinus*) and sweet birch (*Betula lenta*) are common canopy components.
Oak Talus Forest

14. Woodland occurs on coarse, bouldery sandstone talus. Canopy is dominated by dry oaks (*Quercus prinus, Quercus alba, Quercus coccinea, Quercus velutina*) with hickories (*Carya* spp.) and sweet birch (*Betula lenta*) as associates. The herbaceous layer is often dominated by graminoids.

Dry Oak - Mixed Hardwood Forest

6. Vegetation is not restricted to rocky sites with thin soils. In general, current vegetation structure and composition are most influenced by past land management and land use history (for former shale quarry sites, see rocky couplet above).

15. Woodland dominated by conifers such as eastern red-cedar (*Juniperus virginiana*), pine (*Pinus* spp.) or spruce (*Picea* spp.).

16. Open woodland dominated by young eastern red-cedar (*Juniperus virginiana*) with diameters at breast height typically <20 cm. Groundstory vegetation is typically dense and characteristic of Old Field Vegetation and.shrubs are often characterisitic of Successional Shrublands.

Eastern Red-cedar Forest

16. Woodland dominated by pine (*Pinus* spp.) or spruce (*Picea* spp.).

17. Open woodland dominated by young eastern white pine (*Pinus strobus*) with diameters at breast height typically <20 cm. Groundstory vegetation is typically dense and characteristic of Old Field Vegetation and.shrubs are often characterisitic of Successional Shrublands.

Successional Eastern White Pine Woodland

17. Woodland is dominated by scattered established eastern eastern white pine (*Pinus strobus*), red pine (*Pinus resinosa*), Scotch pine (*Pinus sylvestris*), Norway spruce (*Picea abies*), blue spruce (*Picea pungens*) or larch (*Larix* sp.) with diameters at breast height typically >20 cm. Conifers appear planted in a pattern (typically in rows). Adventitious hardwoods may be present. The herbaceous layer is usually sparse with low diversity.

Conifer Plantation

15. Woodland dominated by hardwoods (eastern red-cedar [*Juniperus virginiana*] may be co-dominant in some stands).

18. Groundstory vegetation is typically dense and characteristic of Old Field Vegetation and.shrubs are often characterisitic of Successional Shrublands. Woodland is composed of scattered open-grown trees, of variable species composition.

Wooded Successional Old Field

18. Groundstory vegetation is not characteristic of Old Field Vegetation and shrubs are not characterisitic of Successional Shrublands. Woodland is characterized by early successional, weedy species such as black walnut (*Juglans nigra*), white ash (*Fraxinus americana*), black locust (*Robinia pseudoacacia*), eastern red-cedar (*Juniperus virginiana*), bigtooth aspen (*Populus grandidentata*), black walnut (*Juglans nigra*), black cherry (*Prunus serotina*), red maple (*Acer rubrum*) and eastern white pine (*Pinus strobus*). Invasive shrub and herb species are characteristic and abundant

    19. Black walnut (*Juglans nigra*) is the clear canopy dominant, often with a dense layer of Japanese stilt grass (*Microstegium vimineum*) beneath.

    Black Walnut Bottomland Forest

    19. Black walnut (*Juglans nigra*) is not the clear canopy dominant, although it can be an associate. White ash (*Fraxinus americana*), black locust (*Robinia pseudoacacia*), eastern red-cedar (*Juniperus virginiana*), bigtooth aspen (*Populus grandidentata*), and black cherry (*Prunus serotina*) are common canopy dominants. Invasive shrub and herb species are characteristic and abundant.

    Northeastern Modified Successional Forest

FOREST GROUP

1. Riparian or palustrine vegetation that contains saturated soil for at least part of the growing season OR that occurs in the alluvial or glacial floodplain terraces of the Delaware River Valley. Please note that some terrestrial forest associations can also occur on these floodplain terraces (see couplet 12 below).

    2. Forest is dominated by silver, sugar, or red maple (*Acer* spp.) that constitute at least 25% relative cover of the canopy. Numerous species may be present as associates, but each of the following species do not constitute more than 25% relative cover of the canopy: sycamore (*Platanus occidentalis*), bitternut hickory (*Carya cordiformis*), river birch (*Betula nigra*), eastern hemlock (*Tsuga canadensis*), oaks (*Quercus palustris*, *Quercus bicolor*), ashes (*Fraxinus nigra*, *Fraxinus americana*, *Fraxinus pennsylvanica*), American elm (*Ulmus americana*), and American hornbeam (*Carpinus caroliniana*). If maples constitute 25-50% relative cover, and one of the above species constitutes greater than 25% relative cover, see couplet 6 below.

        3. Forest is dominated by silver maple (*Acer saccharinum*) or sugar maple (*Acer saccharum*). Forest typically occurs on the floodplain of the Delaware River or its major tributaries.

            4. Silver maple (*Acer saccharinum*) constitutes at least 25% relative cover of the canopy; frequently relative cover exceeds 50%. Sugar maple (*Acer saccharum*) can be absent or co-dominant.

                Silver Maple Floodplain Forest

            4. Silver maple (*Acer saccharinum*) and sycamore (*Platanus occidentalis*) are absent or are occasional canopy associates (<25% relative cover). Sugar maple (*Acer saccharum*) constitutes at least 25% relative cover of the canopy and is prominent in the subcanopy; frequently relative cover exceeds 50%. [If sycamore canopy cover exceeds 25% relative cover, see couplet 10 below].

                Sugar Maple Floodplain Forest

        3. Forest is dominated by red maple (*Acer rubrum*) and typically occurs around smaller drainages, in depressions, and near groundwater seepage.

            5. Forest contains red maple (*Acer rubrum*) in the canopy (>50% relative cover) and highbush blueberry (*Vaccinium corymbosum*) in the tall shrub layer (15-50% absolute cover). This association is often semi-permenantly or permenantly flooded.

                Red Maple - Highbush Blueberry Palustrine Forest

5. Highbush blueberry (*Vaccinium corymbosum*) is sparse or absent (<15% absolute cover). Red maple (*Acer rubrum*) is the canopy dominant (25-95% relative cover) with a variety of associates. This association can be temporarily to permenantly flooded.

Red Maple Palustrine Forest

2. Forest is not dominated by silver, sugar, or red maple (*Acer* spp.). Canopy is dominated by one or more of the following species that can constitute more than 25% relative cover of the canopy: sycamore (*Platanus occidentalis*), bitternut hickory (*Carya cordiformis*), river birch (*Betula nigra*), eastern hemlock (*Tsuga canadensis*), oaks (*Quercus palustris, Quercus bicolor*), ashes (*Fraxinus nigra, Fraxinus americana, Fraxinus pennsylvanica*), American elm (*Ulmus americana*), and American hornbeam (*Carpinus caroliniana*). Maples may constitute 25-50% relative cover, if one of the above species constitutes grater than 25% relative cover.

6. Eastern hemlock (*Tsuga canadensis*) composes 25% or greater in the canopy and subcanopy combined. Common canopy associates include red maple (*Acer rubrum*), yellow birch (*Betula alleghaniensis*), and/or blackgum (*Nyssa sylvatica*). Forest occurs along small creeks and drainages.

Eastern Hemlock - Mixed Hardwood Palustrine Forest

6. Eastern hemlock (*Tsuga canadensis*) composes less than 25% in the canopy and subcanopy combined. Canopy dominants are bitternut hickory (*Carya cordiformis*), black walnut (*Juglans nigra*), sycamore (*Platanus occidentalis*), river birch (*Betula nigra*), oaks (*Quercus palustris, Quercus bicolor*), ashes (*Fraxinus nigra, Fraxinus americana, Fraxinus pennsylvanica*), American elm (*Ulmus americana*), and/or American hornbeam (*Carpinus caroliniana*).

7. Canopy dominants are bitternut hickory (*Carya cordiformis*) or black walnut (*Juglans nigra*).

8. Bitternut hickory (*Carya cordiformis*) constitutes at least 25% relative cover of the canopy; frequently relative cover exceeds 50%. Forest occurs on the floodplain of the Delaware River or its major tributaries.

Bitternut Hickory Lowland Forest

8. Black walnut (*Juglans nigra*) is the clear canopy dominant; frequently relative cover exceeds 50%. Forest can occur on the floodplain of the Delaware River, its major tributaries, or in smaller drainages and swales

Black Walnut Bottomland Forest

7. Canopy dominants are sycamore (*Platanus occidentalis*), river birch (*Betula nigra*), oaks (*Quercus palustris, Quercus bicolor*), ashes (*Fraxinus nigra, Fraxinus americana, Fraxinus pennsylvanica*), American elm (*Ulmus americana*), and/or American hornbeam (*Carpinus caroliniana*).

9. Forest is dominated by pin oak (*Quercus palustris*) and/or swamp white oak (*Quercus bicolor*) with 25–75% relative cover in the canopy. Common canopy associates include red maple (*Acer rubrum*), American hornbeam (*Carpinus caroliniana*), ashes (*Fraxinus americana, Fraxinus nigra, Fraxinus pennsylvanica*), and American elm (*Ulmus americana*).

Bottomland Oak Palustrine Forest

9. Mesic oaks (*Quercus palustris, Quercus bicolor*) have relative cover less than 25% in the canopy. Canopy dominants are sycamore (*Platanus occidentalis*), river birch (*Betula nigra*), ashes (*Fraxinus nigra, Fraxinus americana, Fraxinus pennsylvanica*), American elm (*Ulmus americana*), and/or American hornbeam (*Carpinus caroliniana*).

10. Sycamore (*Platanus occidentalis*) constitutes at least 25% relative cover in the canopy.

11. Sycamore (*Platanus occidentalis*) constitutes 50% or greater relative cover of the canopy, usually with ash (*Fraxinus* spp.) as an associate.

Sycamore Floodplain Forest

11. Sycamore (*Platanus occidentalis*) constitutes less than 50% relative cover of the canopy, and co-occurs with sugar maple (*Acer saccharum*), red maple (*Acer rubrum*), silver maple (*Acer saccharinum*), white ash (*Fraxinus americana*) and/or river birch (*Betula nigra*).

Sycamore - Mixed Hardwood Floodplain Forest

10. Forest is typically weedy. None of the following species show clear dominance (>25% relative canopy cover): sycamore (*Platanus occidentalis*), eastern hemlock (*Tsuga canadensis*), mesic oaks (*Quercus palustris, Quercus bicolor*), red maple (*Acer rubrum*), silver maple (*Acer saccharinum*), sugar maple (*Acer saccharum*), or bitternut hickory (*Carya cordiformis*), though these species may be present as associates. Canopy can be dominated by one or more of the following: black ash (*Fraxinus nigra*), American elm (*Ulmus americana*), white ash (*Fraxinus americana*), green ash (*Fraxinus pennsylvanica*), American hornbeam (*Carpinus caroliniana*), and/or river birch (*Betula nigra*).

Bottomland Mixed Hardwood Palustrine Forest

1. Terrestrial forests that do not regularly experience saturated soils during the growing season.

12. Within the canopy and subcanopy combined, conifers have relative cover of 75% or greater.

CONIFEROUS TERRESTRIAL FOREST SUBGROUP

12. Within the canopy and subcanopy combined, conifers have relative cover less than 75%.

13. Within the canopy and subcanopy combined, conifers have relative cover between 25–75%.

MIXED TERRESTRIAL FOREST SUBGROUP

13. Within the canopy and subcanopy combined, conifers have relative cover less than 25%.

DECIDUOUS TERRESTRIAL FOREST SUBGROUP

CONIFEROUS TERRESTRIAL FOREST SUBGROUP

[Note: Due to hemlock decline, observed foliar cover in hemlocks may be lower than the percentages listed in the key.]

1. Successional forest dominated by eastern red-cedar (*Juniperus virginiana*), with some of the following associates: white ash (*Fraxinus americana*), black locust (*Robinia pseudoacacia*), bigtooth aspen (*Populus grandidentata*), black walnut (*Juglans nigra*), black cherry (*Prunus serotina*), red maple (*Acer rubrum*) and eastern white pine (*Pinus strobus*).

Eastern Red-cedar Forest

1. Forest not dominated by eastern red-cedar (*Juniperus virginiana*) with early successional and weedy associates.

    2. Relative cover of pines (*Pinus* spp.) or spruces (*Picea* spp.) in the canopy and subcanopy combined is greater than the relative cover of eastern hemlock (*Tsuga canadensis*) in the canopy and subcanopy combined. Eastern red-cedar (*Juniperus virginiana*) may be common in the subcanopy.

        3. Forest is dominated by eastern white pine (*Pinus strobus*), red pine (*Pinus resinosa*), Scotch pine (*Pinus sylvestris*), Norway spruce (*Picea abies*), blue spruce (*Picea pungens*) or larch (*Larix* sp.). Adventitious hardwoods may be present as associates. Common species include: white ash (*Fraxinus americana*), flowering dogwood (*Cornus florida*), red maple (*Acer rubrum*), black cherry (*Prunus serotina*), American beech (*Fagus grandifolia*), American hornbeam (*Carpinus caroliniana*), sweet birch (*Betula lenta*), oaks (*Quercus* spp.) and hickories (*Carya* spp.). Eastern red-cedar (*Juniperus virginiana*) may be common in the subcanopy. Canopy conifer trees are even-aged and often regularly spaced.

Conifer Plantation

        3. Forest is dominated by eastern white pine (*Pinus strobus*), with associates pitch pine (*Pinus rigida*), eastern hemlock (*Tsuga canadensis*), sweet birch (*Betula lenta*), mockernut hickory (*Carya alba*), black oak (*Quercus velutina*), northern red oak (*Quercus rubra*), sugar maple (*Acer saccharum*), and red maple (*Acer rubrum*). Canopy trees are not even-aged or regularly spaced.

Eastern White Pine Forest

    2. Relative cover of eastern hemlock (*Tsuga canadensis*) in the canopy and subcanopy combined is greater than the relative cover of pines (*Pinus* spp.) or spruces (*Picea* spp.) in the canopy and subcanopy combined.

Eastern Hemlock Forest

MIXED TERRESTRIAL FOREST SUBGROUP

[Note: Due to hemlock decline, observed foliar cover in hemlocks may be lower than the percentages listed in the key.]

1. Successional forest dominated by eastern red-cedar (*Juniperus virginiana*) or eastern white pine (*Pinus strobus*), with early successional, weedy associates such as white ash (*Fraxinus americana*), black locust (*Robinia pseudoacacia*), bigtooth aspen (*Populus grandidentata*), black walnut (*Juglans nigra*), black cherry (*Prunus serotina*), and red maple (*Acer rubrum*). Abundant invasive herb, shrub and vine species are characteristic.

Northeastern Modified Successional Forest

1. Forest is not as described above.

    2. Relative cover of pines (*Pinus* spp.) or spruces (*Picea* spp.) in the canopy and subcanopy combined is greater than the relative cover of eastern hemlock (*Tsuga canadensis*) in the canopy and subcanopy combined. Eastern red-cedar (*Juniperus virginiana*) may be common in the subcanopy.

        3. Forest is dominated by eastern white pine (*Pinus strobus*), red pine (*Pinus resinosa*), Scotch pine (*Pinus sylvestris*), Norway spruce (*Picea abies*), blue spruce (*Picea pungens*) or larch (*Larix* sp.). Adventitious hardwoods are present as associates in the canopy or subcanopy. Common species include: white ash (*Fraxinus americana*), flowering dogwood (*Cornus florida*), red maple (*Acer rubrum*), black cherry (*Prunus serotina*), American beech (*Fagus grandifolia*), American hornbeam (*Carpinus caroliniana*), sweet birch (*Betula lenta*), oaks (*Quercus* spp.) and hickories (*Carya* spp.). Eastern red-cedar (*Juniperus virginiana*) may be common in the subcanopy. Canopy trees are even-aged and often regularly spaced.

Conifer Plantation

        3. Forest is dominated by eastern white pine (*Pinus strobus*), with hardwood associates typical of dry oak forests or northern hardwood forests. Canopy trees are not even-aged or regularly spaced.

            4. Forest occurs on dry sites. Canopy is composed of eastern white pine (*Pinus strobus*), pitch pine (*Pinus rigida*), dry oaks (*Quercus prinus*, *Quercus rubra*, *Quercus velutina*, *Quercus alba*, *Quercus coccinea*), eastern hemlock (*Tsuga canadensis*) and eastern red-cedar (*Juniperus virginiana*) as associates. Common shrubs include bear oak (*Quercus ilcifolia*), mountain laurel (*Kalmia latifolia*), black huckleberry (*Gaylussacia baccata*), lowbush blueberry (*Vaccinium angustifolium*), Blue Ridge blueberry (*Vaccinium pallidum*), deerberry (*Vaccinium stamineum*), and eastern teaberry (*Gaultheria procumbens*). Dense eastern white pine regeneration may be present in shrub layer. The herbaceous layer is typically very sparse (<5% cover).

Dry Eastern White Pine - Oak Forest

4. Forest occurs on dry-mesic to mesic sites. Canopy is composed of eastern white pine (*Pinus strobus*), red maple (*Acer rubrum*), sweet birch (*Betula lenta*), and mesic oaks (*Quercus rubra, Quercus palustris*), with associates eastern-red cedar (*Juniperus virginiana*), eastern hemlock (*Tsuga canadensis*), black cherry (*Prunus serotina*), American beech (*Fagus grandifolia*), white ash (*Fraxinus americana*), bigtooth aspen (*Populus grandidentata*), sugar maple (*Acer saccharum*), bitternut hickory (*Carya cordiformis*) and yellow birch (*Betula alleghaniensis*). Common shrubs include northern spicebush (*Lindera benzoin*), common winterberry (*Ilex verticillata*), blackhaw (*Viburnum prunifolium*), southern arrowwood (*Viburnum dentatum*), Japanese barberry (*Berberis thunbergii*), mapleleaf viburnum (*Viburnum acerifolium*), and raspberries (*Rubus* spp.). Ericaceous shrubs (*Kalmia* spp., *Gaylussacia* spp., *Vaccinium* spp.) may be occasional in this type. The herbaceous layer is usually sparse to moderately dense.

Eastern White Pine - Successional Hardwood Forest

2. Relative cover of eastern hemlock (*Tsuga canadensis*) in the canopy and subcanopy combined is greater than the relative cover of pines (*Pinus* spp.) or spruces (*Picea* spp.) in the canopy and subcanopy combined.

5. Canopy is composed of eastern hemlock (*Tsuga canadensis*), dry oaks (*Quercus prinus, Quercus rubra, Quercus velutina, Quercus alba*), red maple (*Acer rubrum*), sweet birch (*Betula lenta*), hickories (*Carya glabra, Carya alba*), blackgum (*Nyssa sylvatica*), and common serviceberry (*Amelanchier arborea*). Common shrubs include: great laurel (*Rhododendron maximum*), mountain laurel (*Kalmia latifolia*), American witch-hazel (*Hamamelis virginiana*), Blue Ridge blueberry (*Vaccinium pallidum*), lowbush blueberry (*Vaccinium angustifolium*), black huckleberry (*Gaylussacia baccata*). The herb layer is also characteristically sparse (0-10% cover).

Dry Eastern Hemlock - Oak Forest

5. Canopy is composed of eastern hemlock (*Tsuga canadensis*) with mesic associates such as sugar maple (*Acer saccharum*), red maple (*Acer rubrum*), sweet birch (*Betula lenta*), yellow birch (*Betula alleghaniensis*), tuliptree (*Liriodendron tulipifera*), and American beech (*Fagus grandifolia*). Oaks (*Quercus rubra*, Q*uercus alba*, *Quercus prinus*) may be present but are not co-dominant as in the Dry Eastern Hemlock - Oak Forest.

Eastern Hemlock - Northern Hardwood Forest

DECIDUOUS TERRESTRIAL FOREST SUBGROUP

1. In general, forests occur on dry sites, mid- to upper slopes, and ridgetops. In general, forests are dominated by dry oaks (*Quercus prinus, Quercus alba, Quercus coccinea, Quercus velutina, Quercus rubra*) and/or hickories (*Carya glabra, Carya alba, Carya ovalis*). Common associates include red maple (*Acer rubrum*), sweet birch (*Betula lenta*), blackgym (*Nyssa sylvatica*), eastern white pine (*Pinus strobus*), pitch pine (*Pinus rigida*), and eastern hemlock (*Tsuga canadensis*). Characteristic shrubs are ericaceous species (*Gaylussacia baccata, Vaccinium* spp., *Kalmia* spp.*).*

   2. Forests contains dense tall and/or short shrub layer (40-95% absolute cover) dominated by ericaceous species (*Gaylussacia baccata, Vaccinium* spp., *Kalmia* spp.).

      3. Canopy is composed of young quaking aspen (*Populus tremuloides*), bigtooth aspen (*Populus grandidentata*), gray birch (*Betula populifolia*) and sweet birch (*Betula lenta*). Scattered individuals of pitch pine (*Pinus rigida*), scarlet oak (*Quercus coccinea*) and chestnut oak (*Quercus prinus*) may be also present.
      Successional Heath Shrubland

      3. Canopy is composed of established chestnut oak (*Quercus prinus*), northern red oak (*Quercus rubra*) and/or white oak (*Quercus alba*). Other common canopy associates include scarlet oak (*Quercus coccinea*), sweet birch (*Betula lenta*), red maple (*Acer rubrum*), pignut hickoty (*Carya glabra*), black oak (*Quercus velutina*), pitch pine (*Pinus rigida*), blackgum (*Nyssa sylvatica*), sassafras (*Sassafras albidum*), eastern white pine (*Pinus strobus*) and eastern hemlock (*Tsuga canadensis*).
      Dry Oak - Heath Forest

   2. Ericaceous shrubs (*Gaylussacia baccata, Vaccinium* spp., *Kalmia* spp.) cover less than 40% of the forest floor.

      4. The relative cover of hickories (*Carya* spp.) in the canopy and subcanopy combined exceeds the relative cover of oaks (*Quercus* spp.).
      Dry Hickory Ridgetop Forest

      4. The relative cover of oaks (*Quercus* spp.) in the canopy and subcanopy combined exceeds the relative cover of hickories (*Carya* spp.).

         5. Forest occurs on the rocky steep sandstone talus boulderfields. The open forest canopy is dominated by chestnut oak (*Quercus prinus*) and/or sweet birch (*Betula lenta*), with associates pignut hickory (*Carya glabra*), mockernut hickory (*Carya alba*), blackgum (*Nyssa sylvatica*), black oak (*Quercus velutina*), white oak (*Quercus alba*), red maple (*Acer ruburm*), eastern white pine (*Pinus strobus*) and pitch pine (*Pinus rigida*).
         Oak - Birch Talus Forest

         5. Forest does not occur on the rocky steep sandstone talus boulderfields.

6. Chestnut oak (*Quercus prinus*) and/or white oak (*Quercus alba*) are dominant with associates other oaks (*Quercus velutina, Quercus coccinea, Quercus rubra*), red maple (*Acer rubrum*), sweet birch (*Betula lenta*), hickories (*Carya glabra, Carya alba, Carya ovalis*), eastern hemlock (*Tsuga canadensis*), blackgum (*Nyssa sylvatica*), eastern white pine (*Pinus strobus*), pitch pine (*Pinus rigidia*), and rarely sugar maple (*Acer saccharum*). Patches of ericaceous shrubs species (*Kalmia* spp., *Gaylussacia baccata, Vaccinium* spp.) are typical. Common groundstory species are wavy hairgrass (*Deschampsia flexuosa*), Swan's sedge (*Carex swanii*), partridgeberry (*Mitchella repens*), striped prince's pine (*Chimaphila maculata*), Pennsylvania sedge (*Carex pensylvanica*), marginal woodfern (*Dryopteris marginalis*), wild sarsaparilla (*Aralia nudicaulis*), and starflower (*Trientalis borealis*).

Dry Oak - Mixed Hardwood Forest

6. Northern red oak (*Quercus rubra*) is often the most prominent oak species with associates of other oak species (*Quercus velutina, Quercus alba, Quercus coccinea, Quercus prinus*), hickories (*Carya glabra, Carya cordiformis, Carya ovata*), red maple (*Acer rubrum*), sweet birch (*Betula lenta*), sugar maple (*Acer saccharum*), tuliptree (*Liriodendron tulipifera*) and white ash (*Fraxinus amercana*). Common shrubs include American hornbeam (*Carpinus caroliniana*), northern spicebush (*Lindera benzoin*), and Japanese barberry (*Berberis thunbergii*). Characteristic herbs include Christmas fern (*Polystichum acrostichoides*), garlic mustard (*Alliaria petiolata*), and mayapple (*Podophyllum peltatum*).

Northern Red Oak - Mixed Hardwood Forest

1. In general, forests occur on dry-mesic to mesic sites, mid- to lower slopes, and low elevations. In general, forests are dominated by maples (*Acer* spp.), birches (*Betula* spp.), tuliptree (*Liriodendron tulipifera*), American beech (*Fagus grandifolia*), northern red oak (*Quercus rubra*), bitternut hickory (*Carya cordiformis*), and/or American basswood (*Tilia americana*). Also included here are young hardwood forests in which diameter at breast height of canopy trees does not exceed 25 cm for most trees, and forests dominated by early successional or weedy trees with abundant invasive species. Characteristic shrubs are northern spicebush (*Lindera benzoin*), American witch-hazel (*Hamamelis virginiana*), American hornbeam (*Carpinus caroliniana*), common winterberry (*Ilex verticillata*) and raspberries (*Rubus* spp.).

7. Successional forest dominated by early successional, weedy species such as white ash (*Fraxinus americana*), black locust (*Robinia pseudoacacia*), bigtooth aspen (*Populus grandidentata*), black walnut (*Juglans nigra*), black cherry (*Prunus serotina*), red maple (*Acer rubrum*), eastern red-cedar (*Juniperus virginiana*) and eastern white pine (*Pinus strobus*). Abundant invasive herb, shrub and vine species are characteristic.

Northeastern Modified Successional Forest

7. Forest is not dominated by early successional, weedy tree species, invasive herb, shrub and vine species.

8. Oaks species (most commonly *Quercus rubra*, also *Quercus velutina* and *Quercus alba*) constitute at least 25% relative cover in the canopy. Common associates include red maple (*Acer rubrum*), sugar maple (*Acer saccharum*), sweet birch (*Betula lenta*), and hickories (*Carya glabra*, *Carya cordiformis*).

Northern Red Oak - Mixed Hardwood Forest

8. Oaks species (*Quercus* spp.) constitute less than 25% relative cover in the canopy.

    9. Tuliptree (*Liriodendron tulipifera*) constitutes at least 25% relative cover in the canopy. Common associates include red maple (*Acer rubrum*), white ash (*Fraxinus americana*), sweet birch (*Betula lenta*), yellow birch (*Betula alleghaniensis*), and American beech (*Fagus grandifolia*).

    Tuliptree - Beech - Maple Forest

    9. Tuliptree (*Liriodendron tulipifera*) constitutes less than 25% relative cover in the canopy.

        10. Sweet birch (*Betula lenta*) and/or red maple (*Acer rubrum*) constitute at least 50% relative cover in the canopy and subcanopy. Sugar maple (*Acer saccharum*) is not a significant component of the canopy or subcanopy. In general, forest is not restricted to calcareous bedrock. Current species composition and forest structure is generally influenced significantly by previous silvicultural or agricultural activities.

        Red Maple - Sweet Birch Hardwood Forest

        10. Sweet birch (*Betula lenta*) and/or red maple (*Acer rubrum*) constitute less than 50% relative cover in the canopy. Sugar maple (*Acer saccharum*) is a significant component of the canopy or subcanopy. In general, forest tends to occur over calcareous bedrock and is less disturbed than Red Maple - Sweet Birch Hardwood Forest.

            11. American basswood (*Tilia americana*) constitutes at least 25% relative cover in the canopy, with associates sugar maple (*Acer saccharum*), sweet birch (*Betula lenta*), yellow birch (*Betula alleghaniensis*), oaks (*Quercus* spp.), eastern hemlock (*Tsuga canadensis*), and white ash (*Fraxinus americana*). Forest often on steep slopes with diverse, rich herbaceous layer containing bloodroot (*Sanguinaria canadensis*), blue cohosh (*Caulophyllum thalictroides*), dogtooth violet (*Erythronium americanum*), Virginia springbeauty (*Claytonia virginica*), northern maidenhair fern (*Adiantum pedatum*) and Canadian wild ginger (*Asarum canadense*).

            Sugar Maple - American Basswood Forest

11. American basswood (*Tilia americana*) constitutes less than 25% relative cover in the canopy. Canopy dominants include sugar maple (*Acer saccharum*) and sweet birch (*Betula lenta*), with associates northern red oak (*Quercus rubra*), American beech (*Fagus grandifolia*), pignut hickory (*Carya glabra*), red maple (*Acer rubrum*), eastern hemlock (*Tsuga canadensis*), and white ash (*Fraxinus americana*).

Sugar Maple - American Beech - Sweet Birch Forest