

Red Oak - Mixed Hardwood Forest



System: Terrestrial

Subsystem: Forest

PA Ecological Group(s): Appalachian-Northeast Mesic Forest

Global Rank: G4

State Rank: S3S4

General Description

This closed canopy forested community is found throughout Pennsylvania on a variety of landforms ranging from drier mid-to upper slopes and ridgetops to mesic lower slopes and coves. Northern red oak (*Quercus rubra*) dominates the canopy. In addition to the northern red oak, this forest type typically includes tuliptree (*Liriodendron tulipifera*), red maple (*Acer rubrum*), shagbark hickory (*Carya ovata*), sweet birch (*Betula lenta*), and American beech (*Fagus grandifolia*). Sugar maple (*Acer saccharum*) and white ash (*Fraxinus americana*) are often associates on richer sites. Shrubs and understory trees include maple-leaved viburnum (*Viburnum acerifolium*), shadbush (*Amelanchier arborea*), ironwood (*Carpinus caroliniana*), hophornbeam (*Ostrya virginiana*), witch-hazel (*Hamamelis virginiana*), gooseberry (*Ribes cynosbati*), and spicebush (*Lindera benzoin*). The herbaceous layer is variable, but includes species such as bellwort (*Uvularia sessilifolia*), false Solomon's-seal (*Maianthemum racemosum*), may-apple (*Podophyllum peltatum*), Indian cucumber-root (*Medeola virginiana*), wood ferns (*Dryopteris* spp.), Labrador violet (*Viola labradorica*), short husk (*Brachyelytrum erectum*), cutleaf toothwort (*Cardamine concatenata*), two-leaved toothwort (*C. diphylla*), hay-scented fern (*Dennstaedtia punctilobula*), common cinquefoil (*Potentilla simplex*), wax-flower shinleaf (*Pyrola elliptica*), Clayton's sweet-root

(*Osmorhiza claytoniana*), Christmas fern (*Polystichum acrostichoides*), sharp-lobed hepatica (*Hepatica acutiloba*), spring beauty (*Claytonia virginica*), wild geranium (*Geranium maculatum*), ground pine (*Lycopodium obscurum*), and wood anemone (*Anemone quinquefolia*).

The Red Oak – Mixed Hardwood Forest is broadly defined in Pennsylvania and has been widely mapped on Pennsylvania state land. The broad red oak-dominated forest can be further divided into five sub-types following regional and physiological factors such as soils, elevation, and landform, which drive variation in species composition. One of these subtypes is a high-elevation type found at higher elevations in the Allegheny Mountains and characterized by an absence of tuliptree as it occurs above the elevational limits of this species. Red maple may be co-dominate these stands. A second sub-type includes red oak-dominated forests on limestone geology and may share species with the Sugar Maple – Basswood Forests. These forests often include calciphiles, which are not widely distributed in the state. The three remaining subtypes are defined by the ecoregion in which they occur, and often form large matrix forests, and share species with other large mixed hardwood matrix forests. These divisions include a Western Allegheny Plateau/western Allegheny Mountains type, which shares species with hardwood forests in the Western Allegheny Plateau; a red oak – northern hardwood forest of the High Allegheny Plateau and Central Appalachian Mountains ecoregion, which is similar to Northern Hardwood Forests, and a red oak-dominated forest of the Piedmont, which represents red oak forests within the Piedmont and Lower New England ecoregions. These divisions reflect association-level community descriptions in the National Vegetation Classification.

Rank Justification

State Rank: S3-S4

Red Oak – Mixed Hardwood Forests of the Western Allegheny Plateau, Central Appalachian Mountains, and High Allegheny Plateau ecoregions are relatively common matrix-forming forests of western, northern and central Pennsylvania. However, specific subtypes at high elevations, or on calcareous bedrock, or located within the Piedmont ecoregion are much less common. Thus, this type is considered S3-S4 (Apparently Secure) and not rare. Pests, over browsing, non-native invasive plants, and impacts of climate change are cause for long-term concern.

Identification

- Total tree canopy cover is over 70-80%
- Northern red oak is the dominant canopy tree
- Similar to Northern Hardwood Forests, but more oak and reduced maple cover; occasionally reduced birch and beech as well

Characteristic Species

Trees

Red oak (*Quercus rubra*)

Sugar maple (*Acer saccharum*) *

White oak (*Quercus alba*)

Tuliptree (*Liriodendron tulipifera*)

Red maple (*Acer rubrum*)

Yellow birch (*Betula alleghaniensis*)

Sweet birch (*Betula lenta*)

White ash (*Fraxinus americana*) *

Eastern hemlock (*Tsuga canadensis*)

American beech (*Fagus grandifolia*)

Shrubs

Maple-leaved viburnum (*Viburnum acerifolium*)

Northern arrowwood (*Viburnum recognitum*)

Ironwood (*Carpinus caroliniana*)

Smooth serviceberry (*Amelanchier laevis*)

Mountain laurel (*Kalmia latifolia*)

Hop-hornbeam (*Ostrya virginiana*)

Witch-hazel (*Hamamelis virginiana*)

Spicebush (*Lindera benzoin*)

Low sweet blueberry (*Vaccinium angustifolium*)

Lowbush blueberry (*Vaccinium pallidum*)

Herbs

Intermediate wood fern (*Dryopteris intermedia*)

Wild-oats (*Uvularia sessilifolia*)

False Solomon's-seal (*Maianthemum racemosum*)

Mayapple (*Podophyllum peltatum*)

Pipsissewa (*Chimaphila maculata*)

Teaberry (*Gaultheria procumbens*)

Indian cucumber-root (*Medeola virginiana*)

Canada mayflower (*Maianthemum canadensis*)

Blue cohosh (*Caulophyllum thalictroides*)

Pennsylvania sedge (*Carex pensylvanica*)

Hay-scented fern (*Dennstaedtia punctilobula*)

* limited to sites with higher soil calcium

International Vegetation Classification Associations:

USNVC Crosswalk Level: Alliance [A3303](#) Central Appalachian-Northeast Red Oak – Mesic Hardwood Forest

Pennsylvania's Red Oak – Mixed Hardwood Forest includes forest communities dominated by northern red oak and other hardwood species within NatureServe's Central Appalachian-Northeast Red Oak – Mesic Hardwood Forest alliance. In all, there are five different associations attributed to Pennsylvania that share dominant species in the overstory but differ slightly with respect to the composition of the shrub and herbaceous layers. Two of these associations represent common matrix-forming forests of the Western Allegheny Plateau, Central Appalachian Mountains, and High Allegheny Plateau ecoregions of western, northern and central Pennsylvania. Two others, defined by specific geology and elevational factors in the Allegheny Mountains, have more limited distributions (one occurring at higher elevations in the Allegheny Mountains and a second limited to limestone and calcareous sandstone geology).

Representative Community Types:

Red Oak - Transitional Northern Hardwood Forest

USNVC: [CEGL006635](#)

Global/State Ranks: G4/S4

Central Appalachian Red Oak – Northern Hardwoods Forest

USNVC: [CEGL008570](#)

Global/State Ranks: GNR/S4

Central Appalachian Calcareous Red Oak – Northern Hardwoods Forest

USNVC: [CEGL008578](#)

Global/State Ranks: GNR/S2

Western Allegheny Red Oak [Proposed]

USNVC: [CEGL00NEW1](#)

Global/State Ranks: GNR/S4

NatureServe Ecological Systems:

Appalachian (Hemlock) – Northern Hardwood Forest (CES202.593)

NatureServe Group Level:

G742. Appalachian-Northeast Mesic Forest

Origin of Concept

Faber-Langedoen, D. 2021. Central Appalachian Red Oak – Northern Hardwoods Forest (CEGL008570). NatureServe Explorer [web application]. NatureServe, Arlington, Virginia. Available <https://explorer.natureserve.org/>. (Accessed: February 14, 2022).

Faber-Langedoen, D. 2021. Central Appalachian Calcareous Red Oak – Northern Hardwoods Forest (CEGL008578). NatureServe Explorer [web application]. NatureServe, Arlington, Virginia. Available <https://explorer.natureserve.org/>. (Accessed: February 14, 2022).

Faber-Langedoen, D. 2021. Lower New England Oak – Tuliptree Forest (CEGL008573). NatureServe Explorer [web application]. NatureServe, Arlington, Virginia. Available <https://explorer.natureserve.org/>. (Accessed: February 14, 2022).

Fike, J. 1999. Terrestrial and palustrine plant communities of Pennsylvania. Pennsylvania Natural Diversity Inventory. Harrisburg, PA. 86 pp.

Gawler, S. C. and Faber-Langendoen, D. 2014. Red Oak – Transitional Northern Hardwood Forest (CEGL006635). NatureServe Explorer [web application]. NatureServe, Arlington, Virginia. Available <https://explorer.natureserve.org/>. (Accessed: February 14, 2022).

Pennsylvania Community Code

AR Red Oak – Mixed Hardwood Forest

Similar Ecological Communities

This type can be very similar to the Northern Hardwood Forest type, which typically have less of a red oak/oak component, and more sugar maple, birch, beech, and black cherry. The Red Oak – Mixed Hardwood Forest is also similar to the Hemlock (white pine) – Red Oak – Mixed Hardwood Forest, but has greater (>25%) cover from hemlock or white pine. Hemlock – Tuliptree – Birch Forests share species, landscape context, and landform position with the Red Oak – Mixed Hardwood Forest, particularly the occurrences in the Allegheny Mountains. The Hemlock – Tuliptree – Birch Forests, however, have a greater proportion of hemlock in the overstory and rhododendron (*Rhododendron maximum*) in the tall shrub layer.

Fike Crosswalk

Red Oak – Mixed Hardwood Forest

Conservation Value

Oak is an economically important species, both regionally and nationally and has significant value for wildlife. A number of bird species that prefer forest interior conditions will occupy Red Oak – Mixed Hardwood Forests, including the American redstart (*Setophaga ruticilla*), black-throated blue warbler* (*Setophaga caerulescens*), eastern wood-pewee (*Contopus virens*), the yellow-bellied sapsucker (*Sphyrapicus varius*), hairy woodpecker (*Leuconotopicus villosus*), and hooded warbler* (*Setophaga citrina*; Sargent et al., 2017).

*SGCN species

Threats

While there are no short-term conservation risks for the Red Oak – Mixed Hardwood Forest community at this time, it could experience significant long-term changes to the composition or distribution in a changing climate. Some authors have suggested that species that are currently dominant in our northern hardwood forests spectrum, such as sugar maple, eastern hemlock, red maple, or black cherry, could become less common in both high and low emissions scenarios (Iverson et al., 2008). Other

sources have suggested that some oak species, including red oak, have the potential to remain stable or increase across their native range in Pennsylvania (Peters et al., 2020). Forest pests/pathogens could significantly impact tree species in this community type, including spotted lanternfly (*Lycorma delicatula*), spongy moth (*Lymantria dispar*), eastern tent caterpillar (*Malacosoma americanum*), hemlock woolly adelgid (HWA; *Adelges tsugae*), emerald ash borer (*Agrilus planipennis*), and beech bark disease. Invasive plant species that threaten Red Oak – Mixed Hardwood Forests include garlic mustard (*Alliaria petiolata*) and Japanese barberry (*Berberis thunbergii*), among others. Throughout much of its range, the Red Oak – Mixed Hardwood Forest has experienced forest fragmentation from roads, shallow gas development, and habitat conversion. Furthermore, the core range of Red Oak – Mixed Hardwood Forest is found in the shale gas region in Pennsylvania, and potentially in West Virginia, Maryland, New York, and Ohio. Development of the shale gas region may result in additional fragmentation throughout the range in Pennsylvania. Because this type tends to grow on more mesic sites, there is a potential for climate-induced extreme drought to threaten this type.

Management

Red Oak – Mixed Hardwood Forests can be sustainably managed. However, forest conditions may require a specific plan to achieve management goals. Private landowners can consult with service foresters at the Pennsylvania Bureau of Forestry for more information on sustainable forest management practices that are best suited for their property. Management of invasive species is encouraged, and management of white-tailed deer could improve forest regeneration in forests experiencing high rate of herbivory.

Invasive plant species and deer herbivory are of particular concern within the Piedmont ecoregion of Pennsylvania, where the Red Oak – Mixed Hardwood Forest patches are smaller and occur much more commonly as forested woodlots within an agricultural or suburban landscape. Forests in these areas often exhibit signs of severe deer browsing and often lack characteristic understory and groundcover species, on all but the steepest of slopes where, deer pressure is reduced. Garlic mustard (*Alliaria petiolata*) and other non-native plant species are common in the ground cover within these stands.

Research Needs

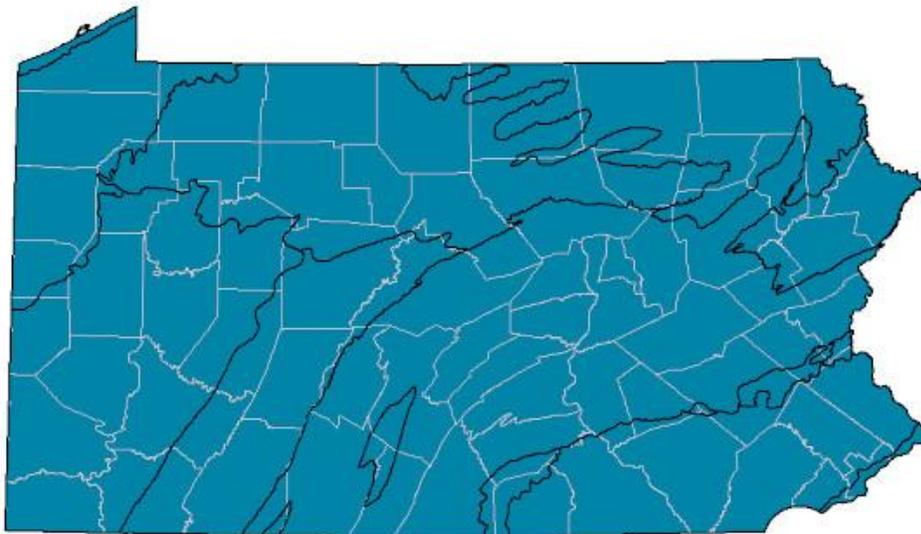
In the context of climate change, monitoring of Red Oak – Mixed Hardwood Forests in northern Pennsylvania could benefit adaptive management efforts. Shifts in species dominance, particularly sugar maple, cherry, red maple, birch, and beech, could impact the distribution of hardwood communities as they are currently described (Bauer et al., 2016; Shortle et al., 2015). If red oak distribution remains stable, or if red oak begins to occupy more forested habitat as a result of climate change, red oak dominated forests could replace Northern Hardwood Forests in some parts of the state. Providing periodic updates to community mapping throughout Pennsylvania may be an effective monitoring tool in the future. Maintaining up-to-date maps of plant communities is both important for rare species as well as more common species for ecological modeling efforts.

Prescribed fire is becoming more commonly applied in oak forests, especially Dry Oak – Heath Forests and Dry Oak – Mixed Hardwood Forests. It is unclear if prescribed fire would benefit the Red Oak – Mixed Hardwood Forests in the same fashion as the drier oak-dominated types. It is assumed that more frequent fire would favor the red oak over the northern hardwood species, however more research is needed. Fire can be used responsibly as a tool for wildlife habitat management and forest management, and pre-and post-burn monitoring could help us better understand forest community response to fire.

Trends

Red Oak – Mixed Hardwood Forests account for approximately 10% of mapped acreage on public lands. Many studies (Abrams & Ruffner, 1995; Black et al., 2006; Johnson, 2013) have used historical vegetation records to determine that oak-dominated forests were common prior to European settlement. However, we have limited historical data for the distribution for red oak-dominated forests in Pennsylvania. Some authors have suggested that red oak and other species (see Abrams & Ruffner, 1995) may be replacing historically dominant species, such as white oak, hickory, white pine and American chestnut in the absence of fire or other disturbance in certain ecoregions (Abrams, 1992, 2003; Abrams & Nowacki, 1992; Abrams & Ruffner, 1995; Nowacki & Abrams, 2008; Signell et al., 2005).

Pennsylvania Range



While we can find Red Oak – Mixed Hardwood Forests throughout Pennsylvania, regional variations exist. These correspond to specific association-level communities identified in the US NVC, which are found within different ecoregions of the state. The following regional variations, crosswalked to the USNVC are as follows:

The Red Oak – Mixed Hardwood Forest (Red Oak - Transitional Northern Hardwood Forest

CEGL006635) has the widest distribution among the five red oak – mixed hardwood forest types. It can be found in the following USEPA Level III ecoregions: Western Allegheny Plateau Ecoregion (USEPA Level III Ecoregion 70), Allegheny Mountains (USEPA Level III Ecoregion 69), Ridge and Valley (USEPA Level III Ecoregion 67), North Central Appalachian Ecoregion (USEPA Level III Ecoregion 62), and Northern Appalachian Plateau (USEPA Level III Ecoregion 60).

The Red Oak – Mixed Hardwood Forest (Central Appalachian Red Oak – Northern Hardwoods Forest CEGLO08570) and the Red Oak – Mixed Hardwood Forest (Central Appalachian Calcareous Red Oak – Northern Hardwoods Forest CEGLO08578) are limited to USEPA’s Allegheny Mountains (USEPA Level III Ecoregion 69).

The Red Oak – Mixed Hardwood Forest (Western Allegheny Red Oak Forest) (CEGL00NEW1) can be found in the USEPA’s Western Allegheny Plateau Ecoregion (USEPA Level III Ecoregion 70) and Allegheny Mountains (USEPA Level III Ecoregion 69).

Global Distribution

Connecticut, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, West Virginia; Ontario

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