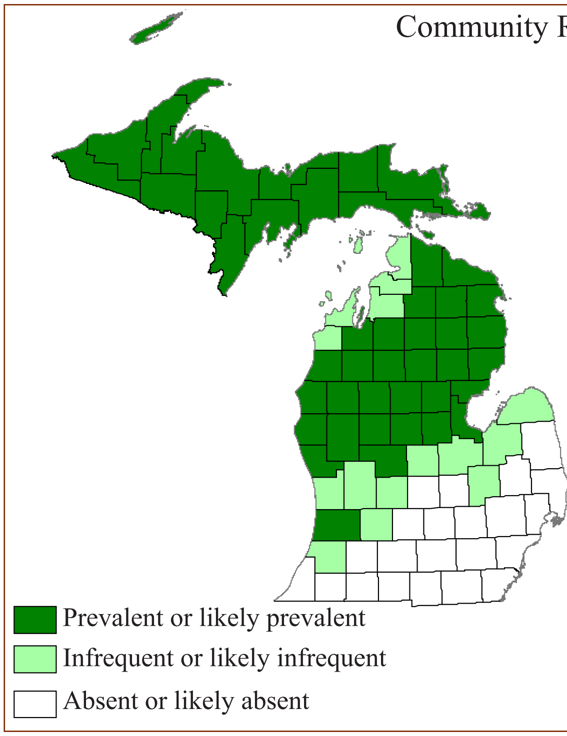
Photo by Joshua G. Cohen



Overview: Dry-mesic northern forests are pine- or pine/hardwood-dominated communities found on sand or loamy sand soils and occurring principally on sandy glacial outwash, sandy glacial lake plains, and less often on thin glacial drift over bedrock, inland dune ridges and coarse-textured end moraines. Prior to European settlement, dry-mesic northern forest typically originated in the wake of catastrophic fire and was maintained by frequent, low-intensity ground fires.

Global and State Rank: G4/S3

Range: Dry-mesic northern forest has existed as a dominant assemblage in the Great Lakes for approximately 5,000-8,000 years, following the peak of the last interglacial warming trend (Davis 1976). The community is found in the central Great Lakes region of the United States and Canada and also extends eastward into the northeastern United States and eastern Canada. It ranges from northern Minnesota and southwestern Manitoba to New Hampshire, Maine, Quebec and the Maritime Provinces (NatureServe 2001). Within Michigan, this forest type is predominantly found throughout the Upper Peninsula and the northern half of the Lower Peninsula above the transition zone. This community also sporadically occurs below the transition zone along the Great Lakes shores of the Lower Peninsula. Presently the distribution of dry-mesic northern forest has been reduced to degraded remnants throughout its original range.

Rank Justification: Widespread selective logging of white pine, red pine and hemlock at the end of the 19th century and the beginning of the 20th century followed by extensive slash fires greatly diminished the acreage of mature dry-mesic northern forest in the Great Lakes region. Logging and subsequent slash fires eliminated potential pine and hemlock seed trees, killed advanced regeneration and incinerated residual seed in the duff (Collins 1958, Curtis 1959). Weaver and Clements (1929) stated that in some areas the destruction of pine forest was so thorough that there were even doubts as to its former existence (Whitney 1986). Slash fires were extremely hot due to the combustion of resinous pine wood, and fires often burned deeply into the ground, destroying the organic surface soil, consuming humus and creating barren stump plains (Reimann 1982) and scrub oak lands (Kittredge and Chittendon 1929). Where fire was less intense or absent, stands of early successional bigtooth aspen, trembling aspen and white birch dominated following the logging of dry-mesic northern forests (Sakai et al. 1985). Beginning in the 1920s, effective fire control by the U.S. Forest Service and state agencies reduced the acreage of forest fires ignited by humans or lightning (Swain 1973). As a result of fire exclusion, many stands of remnant dry-mesic northern forest that escaped the

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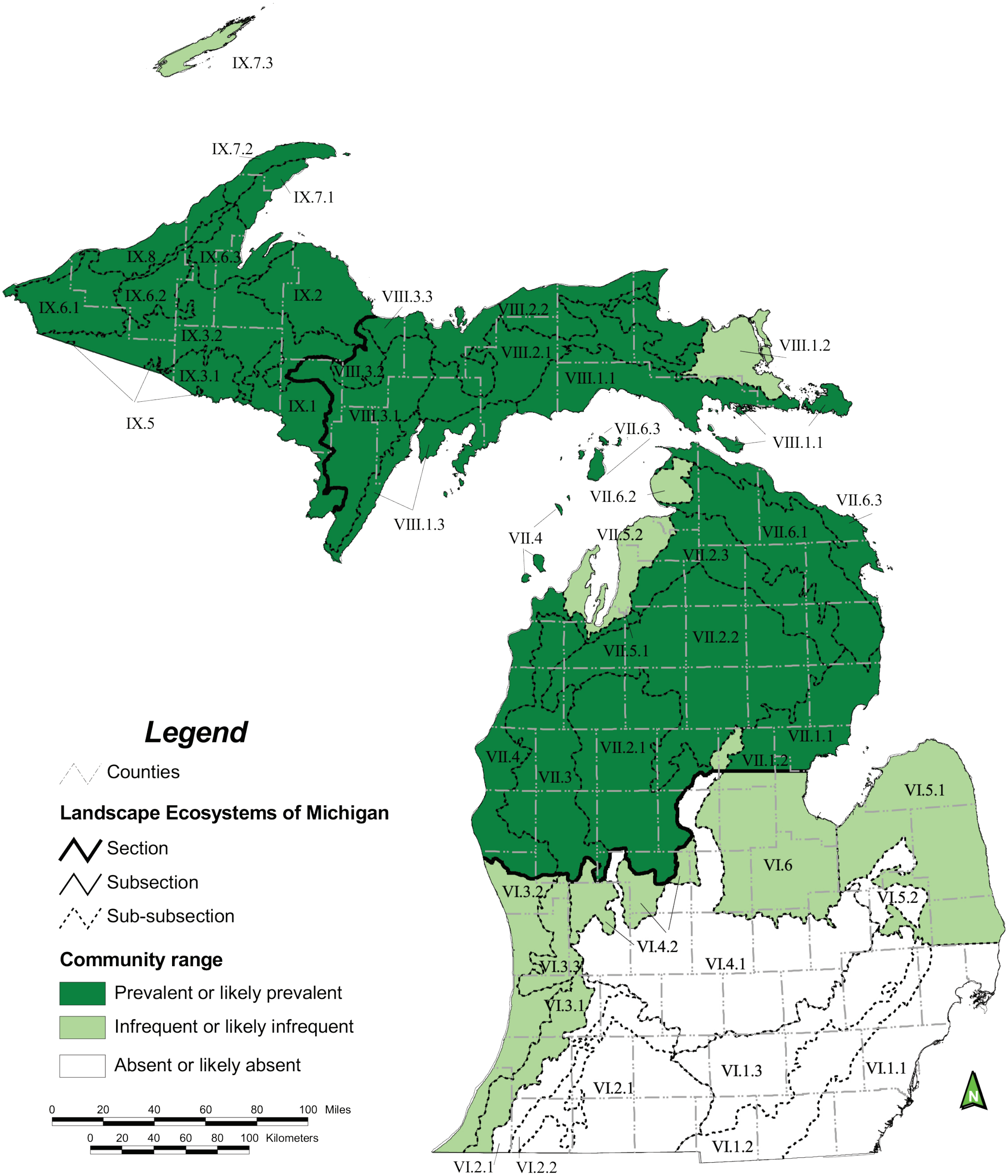

Ecoregional map of Michigan (Albert 1995) depicting distribution of dry-mesic northern forest (Albert et al. 2008)

Photo by Dennis Albert

A pine stump barren in Alger County in the Upper Peninsula.

axe succeeded or are succeeding to the tolerant mesic northern forest community. Sustained and ubiquitous harvesting of residual pine and hardwood co-dominants has reduced the structural and compositional complexity of this community and the forested landscapes in which it is found. In many areas where dry-mesic northern forest failed to regenerate, red and white pine plantations were established and maintained. Successional forests of aspen and birch that replaced dry-mesic northern forests have been maintained and expanded by intensive silviculture and wildlife management geared toward promoting pulp production and providing favorable habitat for game species of early successional forests, particularly white-tailed deer, turkey and grouse.

Old-growth forest has dwindled from 68% to 5.2-8.3% of the Great Lakes landscape (Frelich 1995). Prior to European settlement, dry-mesic northern forests constituted 12% of the forested landscape in Michigan. Frelich (1995) estimated that 55% of this pine forest was old-growth. Of the remaining old-growth in the Lake States just 3.1% (1.6 million acres) is dry-mesic northern forest. Remnants of this forest type unscathed by logging are among the rarest vegetation types in the Lake States; primary red pine/white pine forest is merely 0.6% of the presettlement old-growth red pine/white pine forest (Frelich 1995). Just over 0.2% of dry-mesic northern forest in presettlement condition remains in Michigan (Comer et al. 1995). Currently there are 34 documented occurrences of the dry-mesic northern forest community in Michigan. Only 13 of those occurrences, constituting just over 3,500 acres, are high quality representations of this type. This rare community constitutes less than 0.02% of the present vegetation of Michigan.

Physiographic Context: Dry-mesic northern forests occur principally on sandy glacial outwash, sandy glacial lake plains and less often on thin glacial drift over bedrock, inland dune ridges and coarse-textured end moraines (Curtis 1959, Brubaker 1975, Whitney 1986, Fisher 1994). Prevalent topographic positions of this community are low flat areas and gentle to moderate slopes (Collins 1958). This forest type is common on north and east lake shores, islands, peninsulas, along streams and rivers, to the east, northeast and southeast of natural fire breaks (Heinselman 1973, Swain 1973) and adjacent but downwind from more fire-prone communities like pine barrens, dry northern forest, oak-pine barrens and dry sand prairie (Comer et al. 1995). The soils of dry-mesic northern forest are typically coarse- to medium-textured sand or loamy sand and are moderately to extremely acidic with a surface layer of mor humus resulting from accumulated pine needles (Potzger 1946, Curtis 1959, Whitney 1986, Fisher 1994).

Presettlement forests of white pine, American beech, red maple and red oak were common on rolling, sandy moraines and moderately to well-drained sand plains. Mixed forests of white pine, red pine, black oak and white oak frequently occurred on rolling to steep gravelly landscapes throughout the northern Lower Peninsula. In the central Lower Peninsula and along the lake shore a forest co-dominated by white pine and white oak was characteristic of the dry sand plains. Assemblages dominated by hemlock and white pine were prevalent in the 1800s on moderately drained sand lake plains, ground moraines with fine till and outwash plains extending from Saginaw Bay through the Upper Peninsula. White pine and red pine were frequently co-dominants, concentrated in the northern Lower Peninsula on outwash plains and rolling moraines with sandy or gravelly soils and in the Upper Peninsula along inland dune ridges (Comer et al. 1995).

The Michigan range of the dry-mesic northern forest falls within the area classified by Braun (1950) as the Northern Hardwood-Conifer Region (Hemlock/White Pine/Northern Hardwoods Region) and within the following regions classified by Albert et al. (1986): Region I, Southern Lower Michigan (only along the lake shore and on lake plain); Region II, Northern Lower Michigan; Region III, Eastern Upper Michigan; and Region IV, Western Upper Michigan. The Northern Hardwood-Conifer Region has a cool snow-forest climate with warm summers. The daily

Photo by Josh Cohen

In the Upper Peninsula, white pine and red pine are frequently co-dominants on inland dune ridges within peatland complexes.

maximum temperature in July ranges from 24 to 29 °C (75 to 85 °F), the daily minimum temperature in January ranges from -21 to -9 °C (-5 to 15 °F) and the mean annual temperature is 7 °C (45 °F). The mean number of freeze-free days is between 90 and 160, and the average number of days per year with snow cover of 2.5 cm or more is between 80 and 140. The normal annual total precipitation ranges from 740 to 900 mm with a mean of 823 mm (Albert et al. 1986, Barnes 1991).

Natural Processes: The natural disturbance regime in dry-mesic northern forests is characterized by both infrequent catastrophic fire and frequent stand-perpetuating surface fires. Presently, the prevalent catalyst of fires is lightning strike, but historically, Native Americans played an integral role in the fire regime, accidentally or intentionally setting fire to fire-prone ecosystems (Day 1953, Chapman 1984). Dry-mesic northern forests originate in the wake of stand-leveling fire. Catastrophic stand-leveling fire typically occur during spring and early summer when pine foliar moisture is low, needle starch content is high and, subsequently, pine foliage is highly flammable (Van Wagner 1983, Cayford and McRae 1983). Large-scale, stand-replacing fires also occur during prolonged summer droughts (Heinselman 1973). Conditions conducive to severe crown fire include rainless periods for two weeks or more, several days of low relative humidity, high temperatures and winds and lightning storms of limited extent (Van Wagner 1983). After catastrophic fires in these systems, a patchy mosaic of surviving trees and clumps of trees typically remains and serves as seed trees (Vora 1994). To reproduce, individual red and white pine must survive the catastrophe because their seed crops are intermittent and their cones are not serotinous (Heinselman 1973). If seed trees are nearby, white pine and red pine invade open areas cleared by fire or become established in the understory of pioneer stands of aspen and birch. Curtis (1959) speculated that the presence of a nurse or shelter crop of trembling aspen, bigtooth aspen and/or white birch promotes pine regeneration. After 30 years, the canopy of the pioneer species begins to open up, allowing for the ascendance to canopy dominance of pines and hardwood mid-tolerants. Once established in the overstory, a pine cohort can remain intact for 150-350 years (Heinselman 1973). Heinselman (1981) reported a return interval of 150-200 years for catastrophic crown fires in red and white pine forests of the Boundary Waters Canoe Area of Northern Minnesota. For the red and white pine forests of the northern Lower Peninsula of Michigan, Whitney (1986) estimated a fire return interval of 120-300 years for intense crown fires. These systems also experienced frequent, low-intensity surface fires which burned the fire-prone, well-aerated needle mat and the shrub and seedling layer (Curtis 1959, Van Wagner 1970, Heinselman 1981, Quinby 1991). Red and white pine seedlings typically become established on exposed mineral soils and where competition from tolerant species is minimal. Ground fires provide excellent seedbeds for pine by exposing mineral soil, retarding invasion of mesophytic species and controlling vegetative competition (McRae et al. 1994, Barnes 1989). Mature pine can survive these surface fires due to their fire-resistant characteristics. Mature red and white pine have thick insulating bark (2-5 cm) and are tall (20-40 m) with their first branches occurring high above the ground (often 15 m). These characteristics prevent low-intensity fires from climbing to the crown.

Variation in fire intensity, timing and frequency, which influences the composition, structure and successional character of dry-mesic northern forests, is determined by climatic conditions, soil texture, topography and landscape context (i.e., proximity to water bodies and fire-resistant and fire-conducive plant communities) (Bowles et al. 1994, Chapman et al. 1995). On coarse-textured soils, which are favorable to pine, fires occurred often enough to maintain pine dominance in the canopy and favor pine regeneration (Stearns 1950, Whitney 1986). Stearns found that on more fertile and moist sites, an understory of mesophytic species can develop and becomes dominant in the absence of fire. Following the entrance of hardwoods, the probability of frequent surface fire decreases due to the increase in moisture of the forest (Curtis 1959). As the result of fire suppression, most dry-mesic northern forests are failing to regenerate pine and mid-tolerant species and are being invaded in the understory and canopy by tolerant species (Johnson 1994). As noted by Mutch (1970), species with flammable properties are not adapted to conditions of prolonged fire exclusion, and as a result, fire dependent communities are threatened by impending succession to more mesic conditions. McRae et al. (1994) argued that in the absence of fire, the sustained canopy dominance and regeneration of pine is assured only on rocky and sandy sites where hardwood competition is slight. Inland dune ridges in the Upper Peninsula adjacent to beaver inhabited wetlands are often lacking a hardwood component in the canopy and seedling and sapling layers. It is possible that beaver play a crucial role in selectively harvesting mesophytic hardwood species from these systems.

The natural disturbance regime in dry-mesic northern forests is also influenced by wind. The Great Lakes region is one of the most active weather zones in the northern hemisphere, with polar jet streams positioned overhead much of the year. More cyclones pass over this area than over any other region in the continental U.S. (Frelich and Lorimer 1991). Canham and Loucks (1984) found that blowdowns in presettlement forests of northern Wisconsin occurred in all major forest types and that there was a continuous spectrum of windthrow from small tree-fall gaps to large contiguous patches of several thousand acres. Susceptibility of forest to blowdown and catastrophic windthrow is determined by stand composition, age, structure and local topography. Catastrophic windthrow is an important yet infrequent component of the disturbance regime of the dry-mesic northern forests. Winds greater than 200 km/hr can cause heavy destruction, removing 60-70% of the canopy basal area (Frelich and Lorimer 1991). Canham and Loucks (1984) estimated the return time for large-scale windthrow (> 1.0 ha) to be 1,210 years in forests of northern Wisconsin. This return time is remarkably similar to Whitney's (1986) estimated windthrow recurrence interval of 1,220 years in hemlock/white pine/northern hardwood forests of the northern Lower Peninsula of Michigan. The principal mechanisms for large-scale windthrow are tornadoes and downbursts from thunderstorms. Downbursts are parcels of air in downdrafts that shoot out from the base of thunderstorms and splatter in all directions upon impact with the earth (Frelich and Reich 1996). Severe low-pressure systems are a significant source of small-scale canopy gaps, which generate diversity of age structure in these stands (Canham and Loucks 1984). In a study of the uneven-aged, old-growth white pine system of Temagami, Ontario, Quinby (1991) found that continuous white pine recruitment occurs in response to non-catastrophic wind disturbance in conjunction with surface fires. Quinby found evidence of surface fire and windthrow in 60% and 72% of his plots, respectively. It is possible that ground fires, by creating open conditions in the understory and scorching canopy trees, increase the probability of small-scale windthrow.

Vegetation Description: The dry-mesic northern forest is a broadly defined community type with numerous regional, physiographic and edaphic variations (Brown and Curtis 1952, Curtis 1959, Barnes et al. 1992). Variation in disturbance intensity, seasonality and frequency influences the composition, productivity, structure and successional character of this system. The main dominants of this community are white pine and red pine, with white pine occurring across a broad range of habitat factors and thriving on moist sandy soils and red pine, which is more resistant to drought, prominent on well-drained, coarse-textured sandy upland ridges and plains (Potzger 1946). According to Collins (1958), the percent of red pine increases as site quality (soil moisture and fertility) decreases, and conversely, the percent of white pine increases as site quality increases. Typically white pine and/or red pine form a supercanopy over a subcanopy of trees. The following trees can dominate or co-dominate the subcanopy: *Acer rubrum* (red maple), *Betula papyrifera* (paper or white birch), *Populus grandidentata* (bigtooth aspen), *Populus tremuloides* (trembling aspen), *Quercus alba* (white oak), *Quercus rubra* (red oak), *Quercus velutina* (black oak) and *Tsuga canadensis* (eastern hemlock). Important components of the hardwood canopy for mesic sites dominated by white pine include: *Acer saccharum* (sugar maple), *Betula alleghaniensis* (yellow birch) and *Fagus grandifolia* (American beech). Mesophytic invasion at these sites has been favored by fire exclusion. Tree species associated with this community but most commonly found in the subcanopy include: *Abies balsamea* (balsam fir), *Ostrya virginiana* (hop-hornbeam) and *Picea glauca* (white spruce).

Dry-mesic northern forest is a pine or pine-hardwood forest type that historically originated in the wake of catastrophic fire and was maintained by frequent, low-intensity ground fires. Photos by Joshua G. Cohen.

In terms of their relative importance as arboreal components in the dry-mesic northern forest, these trees differ greatly in importance in different parts of the region and locally within the same region. Significant variation in community composition is proportional to marked differences in local topography, soil, disturbance factors, geographic context (Barnes 1991) and biotic factors such as competitive interactions (Frelich et al. 1993) and browsing pressure (Alverson et al. 1988). Assemblages co-dominated by white pine and red pine occur in the northern Lower Peninsula and in the Upper Peninsula on outwash plains and rolling moraines with sandy or gravelly soils and on inland dune ridges. These white pine/red pine forests, which experienced surface fires every few decades and crown fires on an interval of 120-300 years, often occur downwind from more fire-prone jack pine–dominated systems. Throughout the northern Lower Peninsula on sandy coarse-textured morainal slopes and ridges, white oak, red oak and black oak can occur as subcanopy dominates beneath a supercanopy of white pine and red pine. Aspens and paper birch are often minor components of this type. Often east or downwind of fire-prone sand plains, mixed pine-oak forests probably burned frequently prior to fire suppression. Forests co-dominated by white oak and white pine are found on dry sandy outwash plains and lake plains throughout the central Lower Peninsula and along the Lower Peninsula lake shore. These forests probably burned on a moderate to frequent basis, and surround more frequently burned oak-pine barrens. Prior to fire exclusion, the boundary between these two types was in continual flux, depending on wildfire frequency. White pine occurs in association with red maple, red oak, hemlock, sugar maple and American beech on rolling, sandy moraines and moderately to well-drained sand plains. Comer et al. (1995) speculate that this forest type represents a transition between mesic northern forest and more fire-prone pine-oak forests. Circa 1800, hemlock and white pine co-dominated from Saginaw Bay through the Upper Peninsula on moderately drained sand lake plains and outwash plains. The soils of this type are often sandy loams that are acidic, nutrient-poor and moderately well-drained. Blowdowns and occasional wildfires characterize the natural disturbance of white pine and hemlock forest. The distribution of this type is now limited to remnants in the northern Lower Peninsula and the Upper Peninsula.

The canopy dominants of dry-mesic northern forests can attain heights unparalleled in Great Lakes forests, characterizing dry-mesic northern forests with a unique two-tiered structure. Average mature red pine can grow to be 80 feet (24.4 m) tall and 3 feet (91.4 cm) in diameter but trees up to 150 feet (45.7 m) tall and 5 feet (152.4 cm) in diameter have been documented (Johnson 1994). Collins (1958) systematically sampled the remaining old-growth red pine stands of the northern Lower Peninsula and found mean stand height to range from 70 to 107 feet (21.3-32.6 m) and mean diameter at breast height (dbh) to range from 16.9 to 21.6 inches (42.9-54.9 cm). For the same study, mean stand height and dbh for white pine ranged from 81 to 145 feet (24.7-44.2 m) and 19.2 to 24.8 inches (48.8-63.0 cm), respectively. Mature white pine can reach heights over 200 feet (61.0 m) and diameters over 5 feet (152.4 cm) (Johnson 1994). Within stands surveyed by MNFI, dbh varied from 17.7 to 51.2 inches (45-130 cm). The canopy layer of this community varies widely from relatively open to nearly closed (from 60 to 100% cover). More open stands are dominated by pine and subject to frequent surface fires, while greater canopy closure occurs in fire-suppressed stands with a high component of deciduous trees in the canopy (Brown and Curtis 1952, Curtis 1959, Collins 1958). The light intensity on the forest floor decreases as the shade tolerance of the dominant canopy species increases: more light filters through to the forest floor in pure pine stands compared to pine-hardwood stands. Compared to mesic northern forests, more understory species of dry-mesic northern forests bloom throughout the summer (Curtis 1959).

Prevalent herbs of the dry-mesic northern forest include: *Aquilegia canadensis* (wild columbine), *Aralia nudicaulis* (wild sarsaparilla), *Aster macrophyllus* (big-leaved aster), *Aster sagittifolius* (arrow-leaved aster), *Brachyelytrum erectum, Chimaphila maculata* (striped wintergreen), *Clintonia borealis* (blue-bead lily), *Cornus canadensis* (bunchberry), *Danthonia spicata* (poverty oats), *Epigaea repens* (trailing arbutus), *Lysimachia quadrifolia* (whorled loosestrife), *Maianthemum canadense* (Canada mayflower), *Mitchella repens* (partridge berry), *Oryzopsis asperifolia* (rice grass), *Polygala paucifolia* (fringed polygala), *Streptopus roseus* (twisted stalk), and *Trientalis borealis* (star flower).

Common ferns and clubmosses of this community include: *Dryopteris intermedia*, *Dryopteris spinulosa* (spinulose woodfern), *Pteridium aquilinum* (bracken fern, which is frequently the dominant plant in the ground layer) and *Lycopodium obscurum* (groundpine).

Photo by Josh Cohen

Dry-mesic northern forests typically have a sparse shrub layer. Ground cover is also depauperate, with brakern fern frequently forming a dominant layer. In stands where ground fires have been absent, mesophytic species such as balsam fir and spruce invade the understory.

Characteristic shrubs include: *Acer pensylvanicum* (striped maple), *Acer spicatum* (mountain maple or moosewood), *Amelanchier* spp. (serviceberries), *Arctostaphylos uva-ursi* (bearberry), *Comptonia peregrina* (sweetfern), *Cornus foemina* (grey dogwood), *Corylus americana* (American hazelnut), *Corylus cornuta* (beaked hazelnut), *Diervilla lonicera* (bush-honeysuckle), *Gaultheria hispidula* (creeping-snowberry), *Gaultheria procumbens* (wintergreen), *Gaylussacia baccata* (huckleberry), *Hamamelis virginiana* (witch hazel), *Linnaea borealis* (twinflower), *Lonicera canadensis* (fly honeysuckle), *Parthenocissus quinquefolia* (Virginia creeper), *Prunus virginiana* (choke cherry), *Vaccinium angustifolium* (low sweet blueberry), *Vaccinium myrtilloides* (velvetleaf blueberry) and *Viburnum acerifolium* (maple-leaf viburnum). (Above species lists compiled from MNFI database and from Stearns 1950, Brown and Curtis 1952, Curtis 1959, Gleason and Cronquist 1964 and NatureServe 2001.)

A unique feature of this forest type is the presence of chlorophyll-free, parasitic and saprophytic seed plants such as: Indian pipes (*Monotropa* spp.), coral root orchids (*Corallorhiza* spp.) and pine drops (*Pterospora andromedea*).

Michigan indicator species: *Dalibarda repens* (false violet), *Pinus resinosa* (red pine), *Pinus strobus* (white pine) and *Pterospora andromedea* (pine drops).

Other noteworthy species: Rare plants associated with dry-mesic northern forests include: *Arnica cordifolia* (heart-leaved arnica, state endangered), *Clematis occidentalis* (purple clematis, state threatened), *Dalibarda repens* (false violet, state threatened), *Pterospora andromedea* (pine drops, state threatened), and *Senecio indecorus* (rayless mountain ragwort, state threatened).

Several rare raptor species frequently nest in dry-mesic northern forests: *Accipiter gentilis* (Northern goshawk, state special concern), *Haliaeetus leucocephalus* (bald eagle, state special concern) and *Pandion haliaetus* (osprey, state special concern). *Falco columbarius* (merlin, state threatened) occur within dry-mesic northern forests that are adjacent to wetlands or within close proximity of the Great Lakes shoreline. *Picoides arcticus* (black-backed woodpecker, state special concern) could forage in this forest type when a significant component of standing dead trees is present. Extensive tracts of dry-mesic northern forest provide habitat for large mammals such as moose, bears, wolves and martens. This community provides summer nesting habitat for many neotropical migrants, especially interior forest obligates such as *Dendroica caerulescens* (black-throated blue warbler), *Dendroica virens* (black-throated green warbler), *Piranga olivacea* (scarlet tanager) and *Seiurus aurocappilus* (ovenbird). In a study in the Upper Peninsula of Michigan, Doepker et al. (1992) found that neotropical migrants exhibited a preference for stands with 80% canopy closure where overstory conifer coverage was three times greater than hardwood coverage.

Conservation/management: When the primary conservation objective is to maintain biodiversity in dry-mesic northern forests, the best management is to leave large tracts unharvested and encourage the operation of natural processes (fire, growth, senescence, windthrow, disease, insect infestation, etc.). Long-term preservation of dry-mesic northern forest communities depends on the promotion of fire as the prime ecological process driving persistence and establishment. Heinselman (1973) argued that managers can re-establish the natural fire regime of these systems with prescribed burning. To duplicate the disturbance regime of crown and ground fire, he proposed a combination of spring, summer and fall burns based on lightning fire frequency. Where prescribed fire is not feasible, mechanical manipulation can be utilized to replace both ground fire and catastrophic crown fire (Heinselman 1973, Chown et al. 1986). Chown et al. (1986) suggest that the effects of surface fire can be mimicked by mechanically scarifying the soil, girdling or herbiciding competing vegetation, and under-planting pine seedlings. Catastrophic crown fire can be imitated by clear-cutting all but a patchy mosaic of pine trees and clumps of trees to serve as seed trees. The baseline for the fire management or mimicking mechanical manipulation of natural stands is the patch size and return interval of fire disturbance for a given landscape (Fisher 1994). Current research indicates that prior to European settlement of the Lake States, catastrophic crown fires had a return interval of 120-300 years (Heinselman 1973, Whitney 1986) and ground fires occurred frequently and with low intensity (Heinselman 1973, Whitney 1986, Quinby 1994), suggesting a short return interval (5-20 years). In Michigan, the original land surveyors frequently observed catastrophic fires several square miles in area (Comer et al. 1995). Lorimer and Frelich (1991) estimated the maximum size of an individual downburst in the Great Lakes region to be 3,785 ha. Prior to fire suppression, vast areas of windthrow typically burned over. Given the large scale of the catastrophic disturbance to the landscape, recovery from perturbation requires protection of substantial areas of dry-mesic northern forest. Dry-mesic northern forest complexes designated as old-growth or potential old-growth forest should be larger than the area potentially altered by catastrophic disturbance, or they need to be replicated several times across the landscape (Vora 1994). Johnson and Van Wagner (1985) suggest that a landscape preserve should be at least twice the size of the largest disturbance event.

Large contiguous tracts of old-growth and mature dry-mesic northern forest and mesic northern forest provide important habitat for cavity nesters, species of detritus-based food webs, canopy-dwelling species, understory saprophytic plants and interior forest obligates, including numerous neotropical migrants (Juday 1988). Forest warblers, flycatchers, thrushes, vireos, woodpeckers and woodland raptors are area-sensitive groups dependent on these communities; their populations are larger and fare better within larger habitat patches (Vora 1994). The decline in neotropical migrants coincides with a reduction in natural conifer habitat occurring in upland sites in upper Michigan (Doepker et al. 1992). Timber management and the preservation of biodiversity of dry-mesic northern forests are not mutually exclusive. When tracts of dry-mesic northern forest are being managed for timber harvest, care should be taken to minimize fragmentation, preserve as much area as possible in a forested matrix, maintain a range of canopy closure across the landscape comparable to pre-harvest closure, retain conifer seed trees and utilize fire or mechanical manipulation to promote conifer regeneration. Mimicking gap-dominated disturbances and promoting dead tree dynamics hastens old-growth conditions in managed stands (Runkle 1991). Timber harvest can create openings of natural size and at disturbance rates approximate to old-growth conditions. Timber management practices that maintain or enhance characteristics of mature structure will help protect the biodiversity value of managed stands. Components of mature structure include: standing snags and dead and down woody material in various stages of decomposition and representing a diversity of species and diameter classes, a diversity of living tree species and an overstory dominated by large-diameter trees.

Where remnants of dry-mesic northern forest endure, compositional stability of pine is jeopardized because of fire suppression and the subsequent invasion of mesophytic species and the threat of severe crown fire. Fire exclusion increases the risk of extremely severe fire due to excessive fuel loading in the understory and subcanopy (Chown et al. 1986). In dry-mesic northern forests in which pine is not self-replacing, understory prescribed burning can promote pine regeneration and reduce the probability of severe crown fire. Low-intensity surface fires (underburns) favor pine seedling establishment and growth by preparing a suitable seedbed, releasing nutrients and controlling vegetative competition. Under-burned stands often exhibit a mosaic of open, partial and full canopy. Ground fire scorching of overstory and subcanopy trees can result in patchy removal of portions of the canopy, which increases light and encourages seedling growth. Canopy gaps favorable to white pine regeneration can also be created by an uneven-aged silvicultural system (Quinby 1991). According to McRae et al. (1994) optimum stand age for understory prescribed burning to promote pine regeneration is between 50 and 150 years. When pine trees reach 80 years, their bark becomes thick enough to protect from mortality caused by surface fires. To promote natural seeding, prescribed burning should be employed during years of high seed production and in the spring when seed production peaks. Burning to control vegetative competition often requires multiple burns within the same year or in consecutive years. Typically, one fire is sufficient to girdle understory balsam fir, a thin-barked species. However, multiple fires are required to control hardwood encroachment. In dry-mesic northern forests in which aspen is prevalent in the overstory or understory, prescribed burning or selective cutting of the aspen can result in extensive aspen sprouting and the subsequent promotion of aspen dominance. In such circumstances, if pine is the management objective, patience is perhaps the best management option. As noted by Curtis (1959), a nurse or shelter crop of aspen or birch can promote pine regeneration.

Once established, pine seedlings face numerous perils, including herbivory and insect and fungal infestation. White pine seedlings can benefit from growing in underburned stands and under a shelter crop, which exhibit a wide range of canopy cover. Growing white pine under canopy can be advantageous in preventing serious attack by white pine weevil, since shaded conditions and cool micro-environments retard white pine weevil development. Seedlings growing in areas of partial canopy are protected from blister rust. If blister rust does become established, pine restoration can be enhanced by the removal of infected branches and pruning of branches within two meters of the ground (Vora 1994). Protection from seedling herbivory can be guaranteed by the use of fences or seedling protection tubes (Vora 1994). Management of dry-mesic northern forest communities should be orchestrated in conjunction with the management of adjacent communities such as pine barrens, oak-pine barrens, dry northern forest and mesic northern forests.

Pine plantations, scrub oak and aspen and birch forest now occupy vast areas of former dry-mesic northern forest. Restoration of dry-mesic northern forest from pine plantations, scrub oak and birch forest can be accomplished by employing the above techniques of under-burning and/or mechanical site preparation. In areas dominated by aspen where pine seed trees persist and pine regeneration is pervasive in the understory, the best management strategy is patience as the successional stands provide a beneficial shelter crop for pine regeneration. However, due to the lack of pine seed trees in most of these areas, restoration may require intensive tree planting efforts in conjunction with patience, prescribed fire and/or anthropogenic manipulation.

Research needs: The dry-mesic northern forest exhibits numerous regional, physiographic and edaphic variants. The diversity of variations throughout its range demands the continual refinement of regional classifications that focus on the relationships between vegetation, physiography and soils (Barnes et al. 1982). Investigation into the frequency, periodicity (seasonality), patch size and intensity of surface and crown fires in dry-mesic northern forest is needed to guide restoration and management activities. Given the historical importance of catastrophic fire and windthrow in this system, an important research question to be addressed is how the disturbance regime, structure and species composition of this community will change as the Great Lakes region becomes increasingly fragmented. It is important to understand the ramifications of fire exclusion in dry-mesic northern forests to its flora and fauna, nutrient cycling, energy pathways and landscape patterns (Heinselman 1973). Experimentation is needed to determine how best to utilize surface fire to manipulate competitive mesophytic vegetation, pine recruitment and canopy structure: How are fire frequency, timing and intensity related to understory hardwood mortality, pine seedling regeneration and windfall of canopy trees? The abundance of beaver in wetlands surrounding dry-mesic northern forests begs the question: How do beaver influence recruitment and succession within this community. Because limitations imposed by safety concerns can hamper the effectiveness of prescribed fire, maintaining the ecological integrity of dry-mesic northern forests requires experimentation with different anthropogenic disturbance combinations. Effects of management need to be monitored to allow for assessment and refinement. The prevalence of timber activity in this community demands increased post-harvest monitoring of rare and sensitive species that depend on mature dry-mesic northern forest.

Similar communities: hardwood-conifer swamp, dry northern forest, mesic northern forest, oak-pine barrens and wooded dune and swale complex

Other Classifications:

Michigan Natural Features Inventory Presettlement Vegetation (MNFI):
White Pine/Red Pine, White Pine/White Oak and Hemlock/White Pine

Michigan Department of Natural Resources (MDNR): W-White Pine, R-Red Pine

Michigan Resource Information Systems (MIRIS):
42 (Coniferous Forest), 421 (Upland Conifers), 4211 (White Pine), 4212 (Red Pine), 43 (Mixed Conifer-Broadleaved Forest), 431 (Upland Hardwoods and Pine), 4318 (White Oak and Pine), 4341 (Upland Hardwoods and White Pine) and 4342 (Upland Hardwoods and Red Pine)

The Nature Conservancy National Classification:

CODE; ALLIANCE; ASSOCIATION; COMMON NAME

I.A.8.N.b.12; Pinus resinosa Forest Alliance; Pinus resinosa / Vaccinium spp. Forest; Red Pine /Blueberry Dry Forest

I.A.8.N.b.13; Pinus strobus-Tsuga canadensis Forest Alliance; Pinus strobus-Tsuga canadensis Great Lakes Forest; Great Lakes White Pine-Hemlock Forest

I.A.8.N.b.14; Pinus strobus Forest Alliance; Pinus strobus / Vaccinium spp. Forest; White Pine /Blueberry Dry-Mesic Forest

I.C.3.N.a.20; Pinus strobus – (Pinus resinosa) – Populus tremuloides Forest Alliance; Pinus strobus – Populus tremuloides / Corylus cornuta Forest; White Pine – Aspen – Birch Forest

I.C.3.N.a.21; Pinus strobus – Quercus (alba, rubra, velutina) Forest Alliance; Pinus strobus – (Pinus resinosa) Quercus rubra Forest; White Pine – Red Oak Forest

I.C.3.N.a.21; Pinus strobus – Quercus (alba, rubra, velutina) Forest Alliance; Pinus strobus – Quercus alba / (Corylus americana, Gaylussacia baccata) Forest; White Pine – White Oak Sand Forest

Related Abstracts: black-backed woodpecker, dry northern forest, false violet, merlin, mesic northern forest, northern goshawk, oak-pine barrens, and pine-drops

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Dry-mesic northern forest along the Manistique River, Schoolcraft County, Michigan. Photo by Joshua G. Cohen

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