# Fire Regime Condition Class (FRCC) Interagency Handbook
# Reference Conditions

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**Date:** 26 November 2007

**PNVG Code:** NHDW3

**Potential Natural Vegetation Group:** Northern Hardwoods #2

**Geographic Area:** The Northern hardwood community was mapped by Kuchler in parts of Maine, Vermont, New Hampshire, Pennsylvania, Maryland, Virginia, North Carolina, Ohio, Michigan, and Wisconsin. NHWD3 represents the northern hardwood type within the Lake States, which occurs principally in northern lower Michigan.

**Description:** The northern hardwood, hardwood - fir, hardwood – hemlock, maple – basswood, and maple - spruce Potential Natural Vegetation Groups (PNVG's) are dominantly late successional communities composed of shade-tolerant, long-lived mesophilic species. They occur principally on moraines and fine-textured glacial lake beds.

Mesophilic northern hardwood communities historically changed slowly over centuries. Disturbance and successional dynamics were driven by wind, principally fine-scale blow-down. Rare broad-scale catastrophic storm and fire interactions resulted in fire rotations of more than a thousand years (Cleland et al. 2004, Ziegler 2002, Woods 2000, Canham and Loucks 1984, Frelich and Lorimer 1991, Grimm 1984, Runkle 1982). As a consequence, large portions of the landscape were occupied by late successional old growth forests in which intense disturbance had not occurred for several tree generations (Woods 2000). The absence of catastrophic disturbance favored shade-tolerant, slow growing, and very long-lived species including sugar maple, yellow birch, and hemlock.

Structurally, these unevenaged forests were characterized by large volumes of coarse woody debris lying beneath multi-storied canopies of different aged cohorts, with supercanopies composed of trees centuries old (Tyrell and Crow 1994). The dominant tree species are among the most moisture and nutrient demanding species in the eastern U.S.A., and their distribution is confined to glacial landforms underlain by fertile soils (Woods 2000, Whitney 1986). Composition of the groundflora and understory varies along a moisture-nutrient gradient and typically consists of high densities of shade-tolerant tree species, and a diverse mix of species and plant forms. Herbaceous species range from very mesic (e.g. blue cohosh, yellow violet, sweet cicely, wild leek, bloodroot, various ferns, and ginseng) to a mesic ground-flora depauperate species group where only tree seedlings have substantial coverage.

In the mid-1800's, there were 3.9 million acres of northern hardwood ecosystems within the 10.6 million acres of forestlands in northern lower Michigan (Cleland 2004a, ongoing R-9/SRS/MTU study). Sugar maple, beech, and hemlock were the dominant late-successional species recorded along section lines by GLO surveyors (figure 1). Early successional aspen and oak comprised only 1.8% of the GLO line trees. Composition within this northern hardwood community differs from those in adjacent Wisconsin and the Upper Peninsula of Michigan due to the large proportion of beech, lower proportion of yellow birch, and near absence of balsam fir.

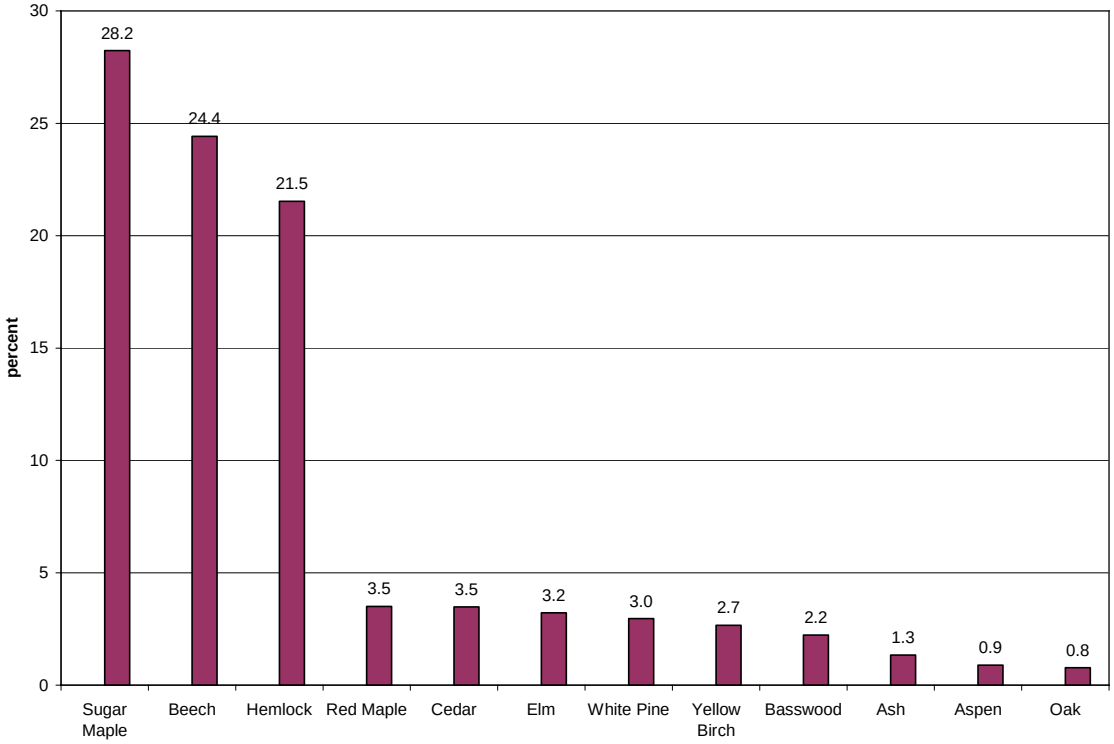



**Figure 1. Percentage of trees in each species recorded within GLO line notes for the "northern-hardwood" potential natural vegetation group of northern lower Michigan.**

**Fire Regime Description:** Destructive fires only occurred within this forest type following catastrophic wind events or during periods of extreme drought. Blowdowns affected conifers more than hardwoods, and older trees more than younger trees (Foster and Boose1992, Webb 1984). The fire-resistance of this community is due to interactions of environmental and biological conditions and processes characterizing this ecosystem. In particular, rapid decomposition of litter and fine woody debris, low light and high humidity along the forest floor, succulent ground-flora and herbaceous layers, moist soils, and the dispersion of volatile coniferous canopies within a fire-resistant deciduous hardwood matrix inhibited ignition and spread of fire. These "asbestos" forests seldom burned (Grimm 1984, Stearns 1949), and exhibited a repeating and shifting steady state of fine-scaled mosaics of species whose overall proportions remained essentially constant (Borman and Likens 1979).

The principal cause of fuel formation leading to fire in northern hardwood ecosystems is broad-scale, storm-driven windthrow of catastrophic proportions (Canham and Loucks 1984, Dunn et al. 1983, Runkle 1982. Canham and Loucks (1984) estimated the return interval for catastrophic storms to be about 1,200 years in northern Wisconsin. They stated "There is potentially a continous spectra of wind-throw from small treefall gaps of one or a few trees to the large, contiguous patches of several thousand hectares of catastrophic windthrow. . ." Their comparisons of the presettlement disturbance regime with contemporary climatological records suggest that catastrophic thunderstorms were the principal mechanism for large-scale windthrow, followed by tornadoes that accounted for one-third of blowdown recorded by surveyors.

Not only were these storms nearly stand-replacing events in themselves, but after the slash resulting from them cured, the probability of fire increased exponentially. However fires within

undisturbed, intact systems that did start or that moved into these stands from adjacent areas tended to smolder in the duff layer and move very slowly, eventually going out and causing little damage to the overstory (Frelich and Lorimer 1991, Stearns 1949).

Within the northern hardwood PNVG of northern lower Michigan, General Land Office survey notes from 1825 -1855 indicate there were 213,729 acres of blown down forests and 31,834 acres of burned areas, (Cleland et al. 2004a, Maclean and Cleland 2003). Assuming a 15-year recognition window, the historical fire rotation was approximately 1,700 years. If surveyors recognized a blow-down 20 years after the event, catastrophic wind rotations would have been 365 years; with a 30-year recognition window the estimate becomes 548 years. Because of the fire-resistance of undisturbed, mesic, deciduous forests, these estimates suggest that approximately 15% of the blown-down areas within this forest type in the Upper Peninsula subsequently burned. Fire regime within this northern hardwood community is similar to those in adjacent Wisconsin and the Upper Peninsula of Michigan, whereas Wisconsin and lower Michigan experienced more frequent catastrophic wind than the Upper Peninsula.

Fire Regime Group V. Severe wind events replace mature stands on an approximate 500 yr rotation. Most replacement fire occurs in slash created by these wind events. Forty percent of the blowdown areas burn and revert to an early seral aspen/birch stage that lasts 60 years. Replacement fires without associated wind events are very rare (5,000 year frequency).

**Vegetation Type and Structure**

| Class* | Percent of Landscape | Description |
|---|---|---|
| **A**: early seral all | 5 | Early seral stands characterized by aspen and yellow birch; 0 to 60 years of age; class following a replacement fire |
| **B**: mid-seral open | 15 | Young stand 0 to 75 years of age dominated by mid-tolerant species. Class A succeeds to this class; Windthrow of mature stands generally result in this class. |
| **C**: mid- seral closed | 15 | Mid age mixed hardwood stands 76 to 150 years of age; Susceptible to windthrow. |
| **D**: late- seral closed | 65 | Old stands greater than 150 years |
| Total | 100 | |

*Formal codes for classes A-E are: AE1A, BM1O, CM1C, and DL1C respectively.

**Fire Frequency and Severity**

| Fire Severity | Frequency (yrs) | Probability | Percent, All Fires | Description |
|---|---|---|---|---|
| Replacement Fire | 1000 | .001 | 100 | |
| Non-Replacement Fire | none | 0 | 0 | |
| All Fire Frequency* | 900 | .001 | 100 | |
| ****Stand replacing windthrow** | **525** | **.0019** | | |

*All Fire Probability = sum of replacement fire and non-replacement fire probabilities. All Fire Fire Frequency = inverse of all fire probability (previous calculation).

**References**

Bormann, F.H. and Likens, G.E. 1979. Catastrophic disturbance and the steady state in northern hardwood forests. American Scientist. 67:660-669.

Canham, C.D. and Loucks, O.L. 1984. Catastrophic windthrow in the presettlement forests of Wisconsin. Ecology 65:803-809.

Cleland, D.T., S.C. Saunders, T.R. Crow, D.I. Dickmann, A.L. Maclean, J.K. Jordan, R.L. Watson, and A.M. Sloan. 2004. Characterizing Historical and Modern Fire Regimes in the Lake States: A Landscape Ecosystem Approach. Landscape Ecology 19: 311–325, 2004.

Cleland, D.T., S.C. Saunders, K.M. Brosofske, A.L. Maclean, J.K. Jordan, R.L. Watson, A.M. Sloan, T.M. Scupien, T.R. Crow, D.I. Dickmann. 2004a. Ongoing project to determine historical and modern wind and fire regimes, fire risk, and historical landscape and community composition and structure in the Lake States and R-9 National Forests.

Davis, M.B., Sugita, S., Calcote, R.R., Ferrari, J.B. and Frelich, L.E. 1994. Historical development of alternate communities in a hemlock hardwood forest in northern Michigan, U.S.A. In Large Scale Ecology and Conservation Biology: The 35th Symposium of the British Ecological Society with the Society for Conservation Biology, pp. 19-39. Edited by P.J. Edwards, R.M. May and N.R. Webb. University of Southampton. Blackwell Scientific Publications: Boston, MA.

Dunn, Christopher P.; Guntenspergen, Glenn R., and Dorney, John R. 1983. Catastrophic wind disturbance in and old-growth hemlock-hardwood forest, Wisconsin. Canadian Journal of Botany. 61:211-217.

Maclean, Ann L. and David T. Cleland. 2003. " Determining the spatial extent of historical fires with geostatistics in northern lower Michigan. IN: Fire, fuel treatments, and ecological restoration. Conference proceedings; 2002 April 16-18. Omi, Philip N.; Joyce, Linda A., tech. eds. Fort Collins, CO. Proc. RMRS-P-29. Fort Collins, CO: Department of Agriculture, Forest Service, Rocky Mountain Research Station. pages 289-300.

Foster, David R. and Boose, Emery R. 1992. Patterns of forest damage resulting from catastrophic wind in central New England, USA. Journal of Ecology. 80:79-98.

Frelich, L.E. and Lorimer C.G. 1991. Natural disturbance regimes in hemlock hardwood forests of the Upper Great Lakes Region. Ecological Monographs 61(2):159-162.
Grimm, E.C. 1984. Fire and other factors controlling the Big Woods vegetation of Minnesota in the mid-Nineteenth century. Ecological Monographs 54:291-311.

Runkle, James Reade. 1982. Patterns of disturbance in some old growth mesic forests of eastern North America. Ecology. 63(5):1533-1546.

Stearns, F.W. 1949. Ninety years change in a northern hardwood forest in Wisconsin. Ecology 30:350-358.

Tyrell, L.E., and T.R. Crow. 1994. Structural Characteristics of Old-growth Hemlock-Hardwood Forests in Relation to Age. Ecology 75:370-386.

Web, S. L. 1989. Contrasting windstorm consequences in two forests, Itasca State Park, Minnesota. Ecology. 70(4):1167-1180.

White, P.S. and Pickett, S.T.A. 1985. Natural disturbance and patch dynamics: An introduction. In The Ecology of Natural Disturbance and Patch Dynamics, pp. 3-13. Edited by S.T.A. Pickett and P.S. White. Academic Press: New York, NY.

Whitney, G.G. 1986. Relation of Michigan's presettlement pine forests to substrate and disturbance history. Ecology 67(6):1548-1559.

Woods, K.D. 2000. Long-term change and spatial pattern in a late-successional hemlock-northern hardwood forest. Journal of Ecology 88:267-282.

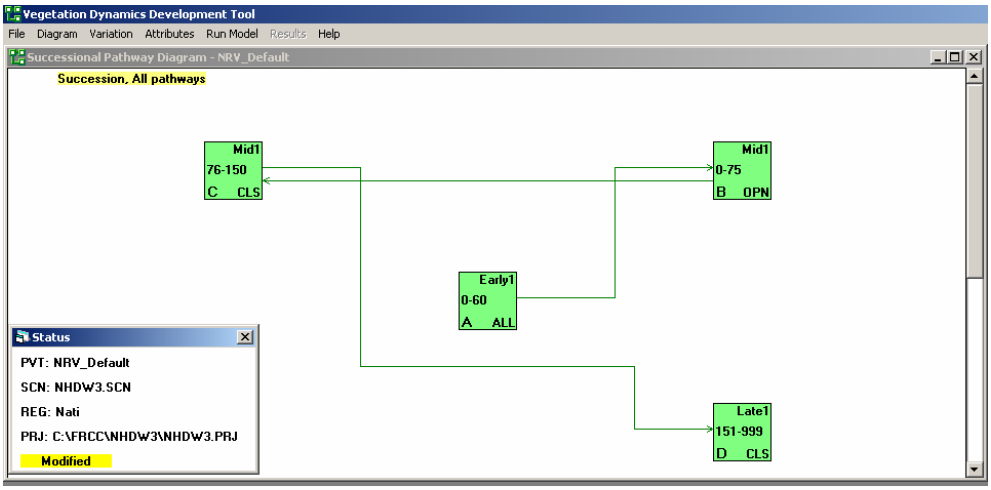
U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory (2002, December). Fire Effects Information System, [Online 12 February 2004]. Available: http://www.fs.fed.us/database/feis/.

Ziegler, S.S. 2002. Disturbance regimes of hemlock-dominated old-growth forests in northern New York, U.S.A. Can. J. For. Res. 32(12): 2106-2115.

U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory (2002, December). Fire Effects Information System, [Online 12 February 2004]. Available: http://www.fs.fed.us/database/feis/.

PERSONAL COMMUNICATION (if applicable):

**VDDT File Documentation:** Model is located in C:\FRCC\NHDW3. Text files must be located in C:\FRCC for project file to work. Diagram shows succession only.




**Disturbance probabilities by class: VDDT model NHDW3**

| Class | To | Agent | Prob | TSD | Freq/ FRI | Rel Age |
|---|---|---|---|---|---|---|
| A | A | Replacement fire | .0025 | 0 | 400 | -60 |
| | | | | | | |
| B | A | Replacement fire | .004 | 0 | 250 | 0 |
| | | | | | | |
| C | A | Replacement fire | .0002 | 0 | 5000 | 0 |
| C | B | Wind/weather/stress | .0025 | 0 | 400 | 0 |
| | | | | | | |
| D | A | Replacement fire | .0002 | 0 | 5000 | 0 |
| D | B | Wind/weather/stress | .0025 | 0 | 400 | 0 |
| | | | | | | |

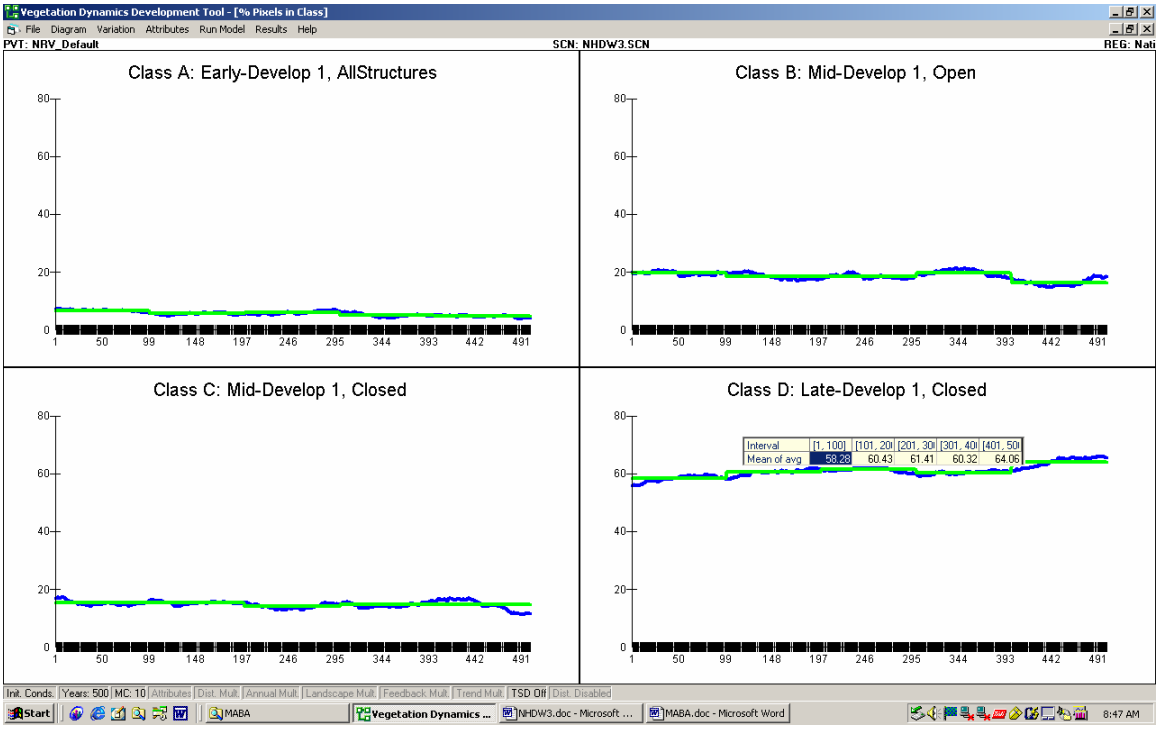
**Class A – early seral aspen, birch < 60 yrs:** A succeeds to young mid seral stands (class B).

**Class B - Mid-succession young forest (0-75 yrs):** Succeeds to class C. Windthrow in older classes returns vegetation to this class. Replacement fires (mostly in slash) result in early seral (assume that 40 % of windthrown areas burn).

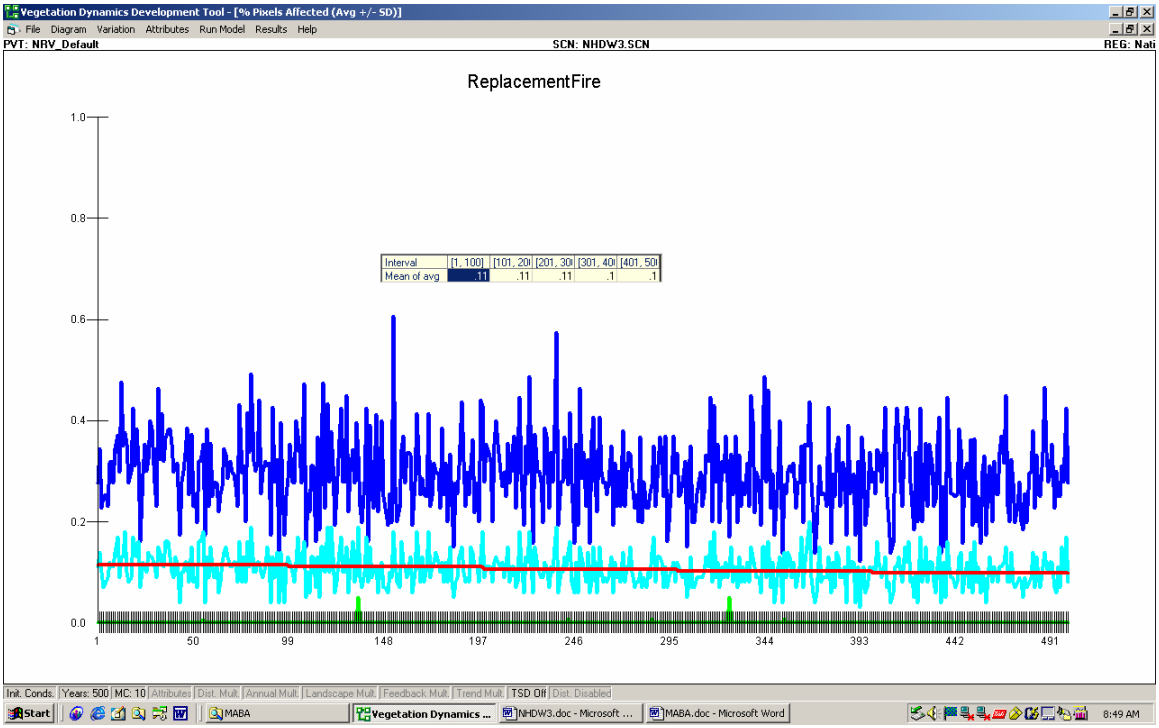
**Class C – Mixed hardwoods (76-150 yrs):** Succeeds to class D. Susceptible to catastrophic windthrow byt replacement fire is very rare.

**Class D – Old late seral forests (> 150 yrs):** End point of succession. Same disturbances as class C.

## Percent acres by class




## Percent of area affected by replacement fires per year (all fires are replacement)



**Per cent of area affected by stand replacing windthrow per year**. (0.19%/yr corresponds to a 525 year wind rotation)