FINAL REPORT ON OLD-GROWTH FORESTS ON WACHUSETT MOUNTAIN

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Three forest ecologists from the Harvard Forest were invited by the Massachusetts Department of Environmental Management (DEM) to undertake a review of the old-growth forest area on DEM land on Wachusett Mountain (WM). Three tasks were identified by DEM as involved in this overview: (1) to provide a review of the report prepared by Vanasse Hangen Brustlin (VHB), Inc., concerning the forest area leased from DEM by the Wachusett Mountain Associates; (2) to conduct additional field reconnaissance to assess the extent and general age, structural, and compositional characteristics of other suspected old-growth forest areas on DEM Wachusett lands outside the leased area; and (3) to make recommendations for further, more detailed studies that would provide information on the developmental history and long-term dynamics of the old-growth forest that would be pertinent to the oversight and management objectives of DEM.

In addressing these three issues we base our comments and recommendations below on an introductory field excursion to Mount Wachusett with DEM personnel in November of 1995, approximately two weeks of field studies conducted in the spring and early summer of 1996, interviews and discussion with Drs. Charlie Cogbill and Peter Dunwiddie (forest ecologists who have conducted the initial assessment of the forest for VHB and the Massachusetts Audubon Society, respectively), and our extensive experience as forest ecologists familiar with the vegetation and forest history of New England and the dynamics of old-growth forest across northeastern North America.

Review of Report by Vanasse Hangen Brustlin

The report by VHB consists of two distinct parts: a lengthy review of the forest history and modern forest conditions of the area of WM leased by Wachusett Mountain Associates prepared by

Dr. Charlie Cogbill, forest ecologist and consultant from Plainfield, Vermont and a briefer, cover letter by Dr. Lisa Standley of VHB. The cover letter is editorial in nature and does not contribute additional scientific data to the Cogbill report.

The Cogbill report is remarkably comprehensive in its review of historical documentation pertinent to understanding the range of natural environmental, disturbance, and land-use history factors that may have impacted the Wachusett area historically and shaped its modern characteristics. Diverse sources that were used in this historical research include original surveys, colonial province records, and legal documents related to the laying out of the towns of Westminster and Princeton, surveys of early roads, ownership deeds, contemporary writings from the 18th, 19th and 20th C (e.g., Peter Whitney's and D. H. Hurd's *History of Worcester County*, H. D. Thoreau's *Journals*., Heywood's *History of Westminster*, F. E. Blake's *History of Princeton*), archival records, diverse cartographic resources from the 19th and 20th C, and interviews with pertinent individuals involved with the history, management and ecology of Massachusetts' forests. The diversity of resources utilized and the scope of this historical overview is consistent with the highest caliber academic research. Considerable effort would be required to improve on the detail of this historical investigation.

Based on historical studies Cogbill makes a number of noteworthy observations including: (1) the longstanding existence of major environmental gradients and corresponding structural and compositional gradients in the forest vegetation across elevation on the mountain; (2) most of the lower slopes of the mountain and adjoining areas were heavily impacted historically for agriculture and wood products; (3) the summit area of the mountain was impacted by tourism and possibly by removal of forest products; (4) the slopes of the mountain were dissected by roads and ski trails; (5) pockets of forest were left untouched through the historical period because they were difficult to access, damaged by natural disturbance or stunted and of low timber value; (6) with the advent of agricultural decline the former open and heavily impacted areas have regrown to forest, creating a nearly continuous matrix of forest surrounding the untouched pockets; and (7) the entire area has been subjected, differentially, to the impacts of slope instability, ice damage, chronic wind exposure

and hurricane winds. We find the historical research on which these conclusions are drawn to be quite sound and we support these basic conclusions.

Based on this historical research Dr. Cogbill conducted a limited (4 days) amount of field work and assembled his observations and data with other information collected by Dr. Peter Dunwiddie into an assessment of the characteristics of the forest. Of particular interest was the age of dominant trees and stand history, determined through dendroecolgoical means, and the structure and composition of the forest, determined through field observations and measurements in fixed plots. Cogbill based his criteria of old-growth status on a system that he developed in 1981 including:

1. a minimum size homogenous area capable of continuously supporting a forest stand (5 acres);
2. minimum percentage of the maximum longevity reachable by the dominant tree species;
3. undetectable human influence;
4. evidence indicating the presence of a subsequent tree generation.

In Cogbill's view "the critical determination is an assessment of specific stand historic integrity and continuity." The field methods and old-growth criteria utilized appear entirely reasonable and appropriate to the objectives of this report. As noted later, much more extensive field work is warranted to evaluate comprehensively the nature and dynamics of these forests.

Field studies by Dr. Cogbill led to the following conclusions related to the area leased from DEM by WMA: (1) forests across the elevational gradient were regularly impacted and shaped by wind, snow, rain and ice-caused breakage, hurricanes, slope instability and other uncertain disturbances; (2) vegetation types and characteristics are strongly controlled by slope position as influenced by bedrock geology, slope, soil depth, and exposure to wind and ice damage; (3) five different communities were identified with four distinct types on the north slope (Toe, Ledge, Hemlock and Brow); (4) tree cores of the Toe site indicate a median age of 172 and maximum of 295 years, with red oak and yellow birch approaching their maximum age. Limited age data from the other communities suggest that: the Ledge site has very old trees (median age >> 133 years on yellow birch) with little indication of disturbance, the Brow has oaks exceeding 200 years of age

with some suggestions of ancient disturbance and one indication of 20th C selective logging, and the hemlock site has trees exceeding 240 years of age and "could have been used historically for tan bark at the approximate time (~ 1860) of establishment of the youngest cored tree"; (5) the forests appear to exhibit little impact of bisection by the four ski trails, liftline and snowmaking pipelines, although the patches of forest between trails indicate edge effects roughly equal to one tree height. The conclusions reached by Dr. Cogbill appear to fit his observations and data well and are corroborated by our own field observations and data collection.

The historical research and field analysis of the northeast slope of WM lead Dr. Cogbill to the following conclusions concerning the old-growth status of the area:

(1) the forest area above the toe of the slope has been generally undisturbed by human activity or natural disturbance and therefore meets the land-use criterion for old-growth;

(2) trees cored on the "mountain lot" of WM have a grand median of more than 177 years and therefore meets the age criterion for old-growth;

(3) the forest has a diverse size and age structure with ample regeneration and therefore meets the stand replacement criterion for old-growth;

(4) a number of the intact forest areas exceed the minimum (5 acres) proposed by C. Cogbill or alternative minimum area (12 acres) for old-growth proposed by P. Dunwiddie.

On the basis of these conclusions Dr. Cogbill argues that the WM area does support significant stands of old-growth forest. Notably, Cogbill suggests that the significance of these forest stands is increased by the diversity of vegetation types, the dominance of deciduous hardwood species, the presence of an unusual yellow birch talus community, the location of WM in the eastern part of Massachusetts, and the relatively large increase that these areas make in the state total of identified old-growth forest. Our field examinations support these conclusions. In addition, and as noted below, the structural characteristics of the forests and individual tree architectures increase the distinctiveness and value of these forests.

Field Observations, Vegetation Sampling, and Dendroecological Analyses

We have undertaken an initial reconaissance of the area to determine the nature and extent of old growth forest with an emphasis on the area outside the WMA leased area studied by Dr. Cogbill. We obtained tree ages and estimated overstory tree basal area at various locations (Table 1). Our preliminary field results suggest that there is a large, intact area of old-growth forest outside the leased ski boundary. The area includes a wide band of forest corresponding to and extending south from the zones referred to as "Toe 4" and "Ledge 3" in the Cogbill report. This area extends from directly above and north of the visitors' center, south and west around the mountain to well beyond Harrington Trail adjoining "Brow 1 and Ledge 1" in the Cogbill report (Sites 3 - 6, Table 1). The majority of trees sampled within this band were red oak and yellow birch which ranged in age from 150 to 250 years old. In addition, observed tree characteristics were consistent with findings by Cogbill of forests subjected to repeated disturbances and harsh growing conditions. Trees were widely spaced and consisted of gnarled, tapering tree boles with stunted canopies containing tufts of small branches. Several locations, especially southern and southeastern aspects, contained evidence of substantial wind disturbance.

Forests corresponding to the"Brow" zone in Cogbill's report located near the summit outside the leased area, varied considerably in structure and composition. The west side of the summit (Site 1, Table 1) contained a dwarf forest of stunted (16 ' tall) red oaks ranging from 100 to 180 years old, while the east side just south of Pine Hill Trail and above Down Summit Road (Site 2) contained beech, and taller, larger red oaks over 200 years old. A few sites within the leased area were also briefly examined for age structure and site characteristics. Tree ages within the narrow band of red spruce on the upper north slope of the mountain (west of Cogbill zone B2) varied from 80 to 150 years old and a yellow birch on the talus slope (Cogbill zone L1) below was approximately 208 years old. The oldest trees cored were two red oaks in the proximity of Old Indian Trail in the lower brow (Cogbill zone B1) and upper toe sections (Cogbill zone T1) which were 285 and 307 years old, respectively. We very roughly estimate the acreage of old growth forest outside the leased area to be from 75 to 100+ acres. This forest is contiguous with similar forest

inside the leased area which further enhances the ecological significance and statewide importance of the site.

Proposed Research

The old-growth forests on Mt. Wachusett represent a rare opportunity to examine forest development, structure, and successional dynamics of sites which have largely been eliminated from the eastern U.S. landscape. These trees contain lengthy records of growth in their annual rings and therefore provide important insight into past events including frequency and intensity of disturbances, stand characteristics, tree recruitment events, and general climatic information. This information is extremely valuable for increasing our understanding of the historical, and current, ecological development of forest stands and will be useful for directing protection and management efforts in these stands. The old-growth hardwood forest stands on Wachusett Mountain present the opportunity for urgently needed additional comprehensive research. This site contains some of the few apparently undisturbed old-growth forests located east of the Connecticut River in Massachusetts and as such the rarity, hardwood nature, and elevational setting of these stands allows an unusual opportunity to investigate the natural dynamics and development of this forest ecosystem. In view of the potential significance of this site we recommend further evaluation of the successional status and long-term forest stand dynamics of the area by examining the age, structure, and composition of the vegetation in conjunction with a dendroecological analysis of growth patterns of young and old trees and analysis of the orientation of downed stems. A suggested protocol for continuing this important research follows.

Vegetation would be sampled in permanent plots established along transects in designated old-growth stands. Plots would be spaced at predetermined intervals through representative portions of designated old-growth forest and plot corners would be permanently marked with iron pipe. In each plot, the species, diameter at breast height (dbh), and canopy position would be recorded for each woody stem larger than a certain diameter (8 cm recommended). A relative importance value would be calculated for each species by summing relative density and relative dominance (basal area) and dividing by two. All saplings (stems $>$ 1.5 m tall and $<$ 8 cm dbh)

would be counted by species within each overstory plot and all seedlings (stems < 1.5 m tall) would be counted by species within 5 - 10 randomly located 1 m^2 nested sub-plots. Shrub and herbaceous cover (%) would also be estimated within each nested sub-plot.

For radial growth analysis and age determinations several trees in each plot, randomly selected and spanning all species and size classes, would be cored with increment borers at 1.37 m height. Cores would be air dried, mounted, sanded, and aged with a dissecting microscope. Ring widths would be measured to the nearest 0.01 mm.

Within representative stands the orientation of downed trees would be ascertained to examine the extent of wind damage and document other unknown disturbance events. Each windblown stem would be identified by species when possible, otherwise as hardwood or conifer, and classified as uprooted, bole snapped, or unknown. The slope, aspect, and topographic position would be characterized at each location.

Table 1. Results of preliminary field studies and dendroecological analysis on Wachusett Mountain. Data are organized by site, keyed to Figure 1 and include information on the species diameter, age, and notes pertaining to individual trees that were cored. The basal area of the forest surrounding selected coring locations was obtained using a 10-factor cruise-all.

Site 1 (dwarf forest)

Core #	Species	DBH	Age	Cruise ($ft.^2$ /acre)
1	red oak	28.5	102+	RO 100
2	red oak	43.2	181+	RO 60 beech 50 Rm 10
3	red oak	43.4	173	BC 10 RO 40 beech 80
--	Red oak (rotten)		(Hick 10, BC 10, YB 10, RO 70, Rm 10)	

Site 2 (corner above down summit road)

Core #	Species	DBH	Age	Cruise ($ft.^2$ /acre)
4	red oak	41.8	205	RO 40 beech 60
5	red oak	43.1	206?	beech 60 RO 50 Rm 10 str.m 20

Site #3 (proceeding southwest from pine hill trail) (May 16, 1996)

7	red oak	48.3	126	RO 50
8	red oak	66.0	199 est. 203	YB 20 Rm 20 Ostrya 20
9	beech	50.8	217	YB 10 beech 80 str.m 10 RO 10
10	Y. birch	41.7	120+	S.hick 10 Sug.m 30 RO 10 YB 40
11	red oak	68.2 broke rotten center	112 (outer 10 cm !)	RO 80 Ostrya 20 W.Haz 10 Rm 40 W.ash 10
12	red oak	53.0	188	RO 90 beech 10
13	red oak	73.3	252+ (no center reached)	RO 40 Rm 20 S.hick 10 Sug. m 20 beech 10 W. haz. 10

not far from Loop trail

Site 4 Down Harrington Trail

14	red oak	52.1	192+ (rotten center)	Ro 80 Hem 10 bbirch 10 Rm 40

Site 5. Above visitor center, below Down summit road, along upper to mid-slope talus, heading south to just beyond the Harlow overlook (plus core #7 above Down summit road, on south side of Pine Hill Trail .

Core #	Species	DBH	Age	Cruise (ft.^{2} /acre)			
1	red oak	73.9	103 + +	--			
2	red oak	55.3	222	--			
3	red oak	60.0	182	--			
4	Y. birch	70.1	162	YB	50	Str.m.	30
5	Y. birch	52.9	216	YB	20	RO	30
				Rm	10	hem	20
6	Y. birch	37.7	176	YB	50	Str.m	10
7	red oak	46.8	190	RO	40	beech	30
				Str.m	10	Rm	10

Site 6. Southwest of Up Summit Road.

Core #	Species	DBH	Age
11	B. Cherry	51.1	95
12	red oak	73.2	195 (estimated 205-210)

Red Spruce Stand (and adjoining talus)

1	R. spruce	36.0	64
2	R. spruce	40.9	150
3	R. spruce	41.8	83
4	R. spruce	36.0	140
5	Y. birch	29.3	208

Old Indian Trail (East and West of trail)

8a	red oak	71.4	285
8	Y. birch	44.1	154
9	red oak	55.5	307

Site 7. Northeast of Echo Lake. East of power line.

Core #	Species	DBH	Age
1	red oak	74.3	196
2	sugar maple	77.2	166
3	hemlock	64.5	173
4	hemlock	49.2	238
5	red oak	28.0	171
6	red oak	53.3	219

Generalized Location of Old Growth Stands
Wachusett Mountain State Reservation