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Forest Vegetation Monitoring in Acadia National Park

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CONTENTS

INTRODUCTION 1

METHODS 3
  Research Site 3
  Plot Locations 4
  Plot Design 5
  Measurements Recorded 7
  Foliar Analysis 10
  Statistical Analysis 11

RESULTS 12
  Cadillac Brook Watershed 12
  Hadlock Brook Watershed 20
  Foliar Chemical Analyses 23

DISCUSSION 25
  Disturbance History and Vegetation Patterns at Acadia 25
  Forest Vegetation at Acadia Compared with BBWM 29
  Foliar Chemical Analyses at Acadia 30
  Foliar Chemistry at Acadia Compared with BBWM 31

CONCLUSIONS/IMPLICATIONS 33

LITERATURE CITED 35

APPENDIX 38

TABLES

1. FHM damage and mortality indicator 9
2. Vegetation types within the plots in Cadillac Brook and Hadlock Brook watersheds 13
3. Species composition of trees, saplings, and seedlings, in Cadillac Brook and Hadlock Brook watersheds 16
4. Mean, median, range, standard deviation, and standard error for tree dbh, height, live crown ratio, and tree crown width in Cadillac and Hadlock watersheds 17
5. Percentage of trees, saplings, and seedlings grouped by crown vigor within the three crown classes in the deciduous forest type in Cadillac Brook watershed and the deciduous and coniferous forest types in Hadlock Brook watershed 18
6. Percentage of damage signs and symptoms recorded for trees, all species combined 19
7. Percentage of damage signs and symptoms recorded for saplings, all species combined 21
8. Percentage of seedlings with crowns exposed to high, moderate, limited, or poor direct overhead sunlight in Cadillac Brook watershed and Hadlock Brook watershed 22
9. Mean and standard deviation of nutrient concentrations in *Acer rubrum* and *Picea rubens* in Cadillac Brook watershed and Hadlock Brook watershed 24
10. Overall comparisons between Acadia National Park, deciduous and coniferous forest types only, and Bear Brook Watershed 30

FIGURES

1. Location of Cadillac Brook watershed and Hadlock Brook watershed in Acadia National Park 3
2. Location of the vegetation monitoring plots in Cadillac Brook watershed in Acadia National Park. 5
3. Location of the vegetation monitoring plots in Hadlock Brook watershed in Acadia National Park. 6
4. PRIMENet plot design for vegetation monitoring at Acadia National Park. 7
5. Vegetation types within Cadillac Brook watershed in Acadia National Park 26
6. Vegetation types within Hadlock Brook watershed in Acadia National Park 27

INTRODUCTION

Airborne pollutants are being transported up the coastline from eastern states and/or eastward from central states and are affecting ecosystems along the coastal region of Maine. One of the highlighted features on the coast of Maine is Acadia National Park on Mount Desert Island. In 1996, the Park Research and Intensive Monitoring of Ecosystems Network (PRIMENet) was established by the US Environmental Protection Agency (EPA) and the US Department of the Interior, National Park Service (USDI, NPS) to examine long-term trends and linkages between environmental stressors, such as airbone pollutants, and ecosystem responses (USDI NPS 2000). Environmental stressors being monitored in 14 National Parks include air quality and deposition and toxic contaminants. The air quality monitoring (operated by the NPS Air Resources Division [ARD]) includes visibility, gaseous pollutants (e.g., ozone [0_3] and sulfur dioxide [SO_2]), and wet and dry deposition. Mercury (Hg) wet deposition monitoring is being conducted in two National Parks: Acadia in Maine and Everglades in Florida. As a trace metal, mercury contamination is a major concern due to its deleterious effects on human health and on the wildlife food-chain, particularly in relation to consumption of mercury-contaminated fish and shellfish (US EPA 1994a).

Goals for the multidisciplinary PRIMENet research undertaken at Acadia were twofold. First, to examine the ecological consequences of atmospheric deposition of nitrogen (N) and Hg on surface waters, soils, and vegetation in two watersheds dominated by different forest-types (Kahl 2000). Second, to relate the results of atmospheric deposition on surface waters, soils, and vegetation from Acadia with results from Bear Brook Watershed in Maine (BBWM), a paired-watershed research area located about 60 km north of the Park. Since 1989, one watershed at BBWM has been manipulated with bimonthly additions of granular, dry ammonium sulfate at the rate of 300 eq NH_4 and SO_4 ha^1 application. Details on the BBWM site and the chemical treatment are available elsewhere (Kahl et al. 1999; Norton et al. 1999). Past research studies at BBWM have examined impacts of enhanced atmospheric deposition on surface waters (Norton et al. 1999), forest soils (Rustad et al. 1996), and forest vegetation (Eckhoff 2000; Eckhoff and Wiersma 2002; Weber and Wiersma 1997; White et al. 1999).

Some of the USDA Forest Service's Forest Health Monitoring (FHM) program indicators were used in the vegetation component of this PRIMENet research at Acadia. The FHM program was developed jointly by the EPA, the Forest Service, and several other agencies to address concerns about potential effects from air pollution, acid rain, global climate change, insects, diseases, and other stressors (Alexander and Palmer 1999). Since the early 1990s, FHM indicators have been used across the USA as part of a national program to assess forest health (US EPA 1994b). FHM indicators were also used to assess the status of the forest vegetation at BBWM (following seven to eight years of ammonium sulfate additions) (Eckhoff 2000). FHM indicators used at Acadia included forest mensuration, crown condition classification, and damage and mortality indicators. An additional vegetation-monitoring indicator, foliar chemical analyses, was also applied at Acadia. Two tree species were selected for the analyses: *Acer rubrum* and *Picea rubens*. Foliar chemical analyses on these two tree species had been previously done at BBWM (following four years of ammonium sulfate additions) (White et al. 1999).

The goal of this report is to present the results of the vegetation component of the PRIMENet study at Acadia. The results include a classification of vegetation-types and their locations within Cadillac Brook and Hadlock Brook watersheds; a synthesis of the primary and meta tree, sapling, and seedling data from the two study watersheds; and foliar chemical analyses using *A. rubrum* and *P. rubens* from Cadillac Brook and Hadlock Brook watersheds. One of the objectives of the study was to determine if there was any significant difference in the foliar chemistry between the two watersheds for either of these tree species. This report also presents a comparison of the results of the foliar chemical analyses from Acadia with reported foliar chemical analyses results from BBWM. The comparison will show whether the foliar chemistry in the watersheds at Acadia is more similar to the control watershed at BBWM (exposed to ambient levels of atmospheric deposition) or the manipulated watershed at BBWM (with enhanced levels). Thereby helping to further describe the status of the forest vegetation in Acadia.

This report provides the baseline information for long-term forest vegetation monitoring in the deciduous and coniferous forests in Cadillac Brook and Hadlock Brook watersheds. Ongoing interest and studies on the status of the natural resources within Acadia National Park makes availability of information from previous work, such as the baseline data in this report, very important.

METHODS

Research Site

Acadia National Park is located in Hancock County, Maine, on Mount Desert Island (MDI), which is situated within the Gulf of Maine (Figure 1). Several historical factors have influenced the current composition and structure of the vegetation within the Park. In the early 1800s farming, lumbering, and fishing were major occupations on MDI (NPS 2001a). By the late 1800s the area had also developed into a major tourist location and wealthy families such as the Rockefellers, Morgans, Fords, Vanderbilts, Carnegies, and Astors built large estates on MDI. The beginning of what is now Acadia National Park was established in 1916 when President Wilson announced the creation of Sieur de Monts National Monument on MDI. In 1919, through an act of Congress, the

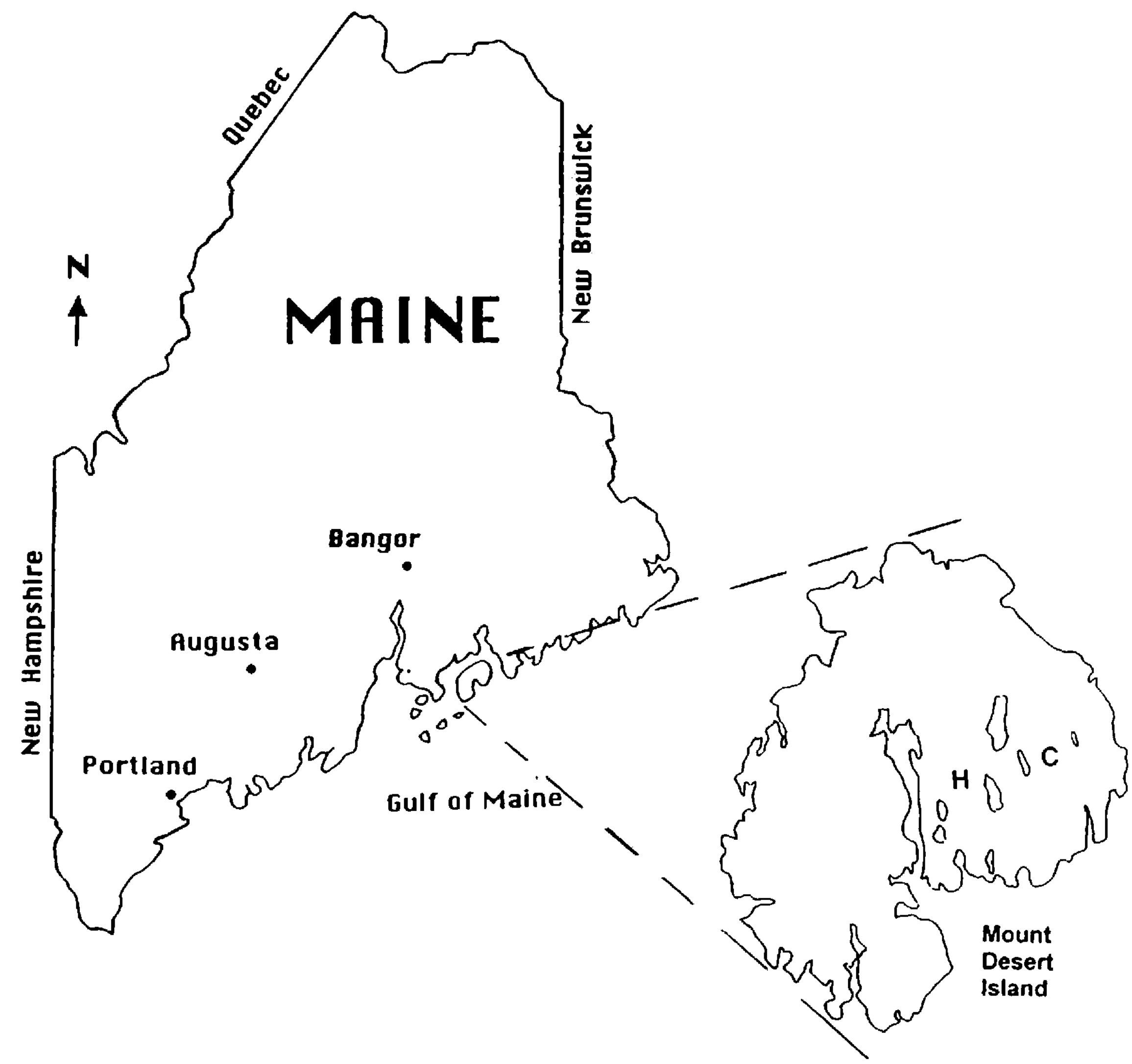

Figure 1. Location of Cadillac Brook watershed (C) and Hadlock Brook watershed (H) in Acadia National Park on Mount Desert Island, Maine.

area became Lafayette National Park and in 1929 the Park name was changed to Acadia. Acadia currently encompasses 35,000 acres on MDI and in the surrounding region.

In the fall of 1947, following a very dry summer, wildfires burned more than 17,000 acres on MDI (NPS 2001b). More than 10,000 of those acres were scattered within Park boundaries. Aboveground fires, fanned by high winds, burned from October 17th to 27th. Smoldering below-ground fires persisted until November 14 when the fires were declared extinguished. Following the fires, areas of the Park were logged as timber salvage operations removed trees damaged by the fires. In the areas of the Park that burned, the present vegetation is the result of natural regeneration and successional processes.

Another large-scale disturbance within the Park occurred in January 1998. A severe ice storm, lasting six days, affected the northeastern and New England states and southeastern Ontario and western Quebec, extending somewhat into New Brunswick and Nova Scotia. During subsequent winter months, additional smaller-scale ice storms reoccurred in the area of Acadia. Damage to the vegetation included broken tops and losses of major limbs. Other natural disturbances that occur in the Park include winter storms and also rockslides and water scouring in some parts of the Park.

For this study two distinct watersheds were selected within Acadia National Park. Cadillac Brook watershed is located on the southeast face of Cadillac Mountain (elevation 470 m); much of this watershed was affected by the wildfire in 1947. The area of the watershed is 31.8 ha. Hadlock Brook watershed is located on the south slope of Sargent Mountain (elevation 418 m). The area of the watershed is 42.7 ha. The vegetation in Hadlock Brook watershed has been largely unaffected by wildfire events. Both watersheds include first-order streams.

Plot Locations

In the fall of 1998, a pilot study involving mensuration measurements of trees, saplings, and seedlings was conducted in Hadlock Brook and Canon West watersheds. (Canon West watershed is located adjacent to Cadillac Brook watershed.) Based on results from the pilot study, in 1999 30 vegetation-monitoring plots were established in Cadillac watershed (Figure 2) and 30 in Hadlock watershed (Figure 3). Plot locations were selected randomly using a grid overlay on the watershed maps. Field locations of the 60 plots were recorded with a global positioning system (GPS); this information has been incorporated within a larger Acadia National Park

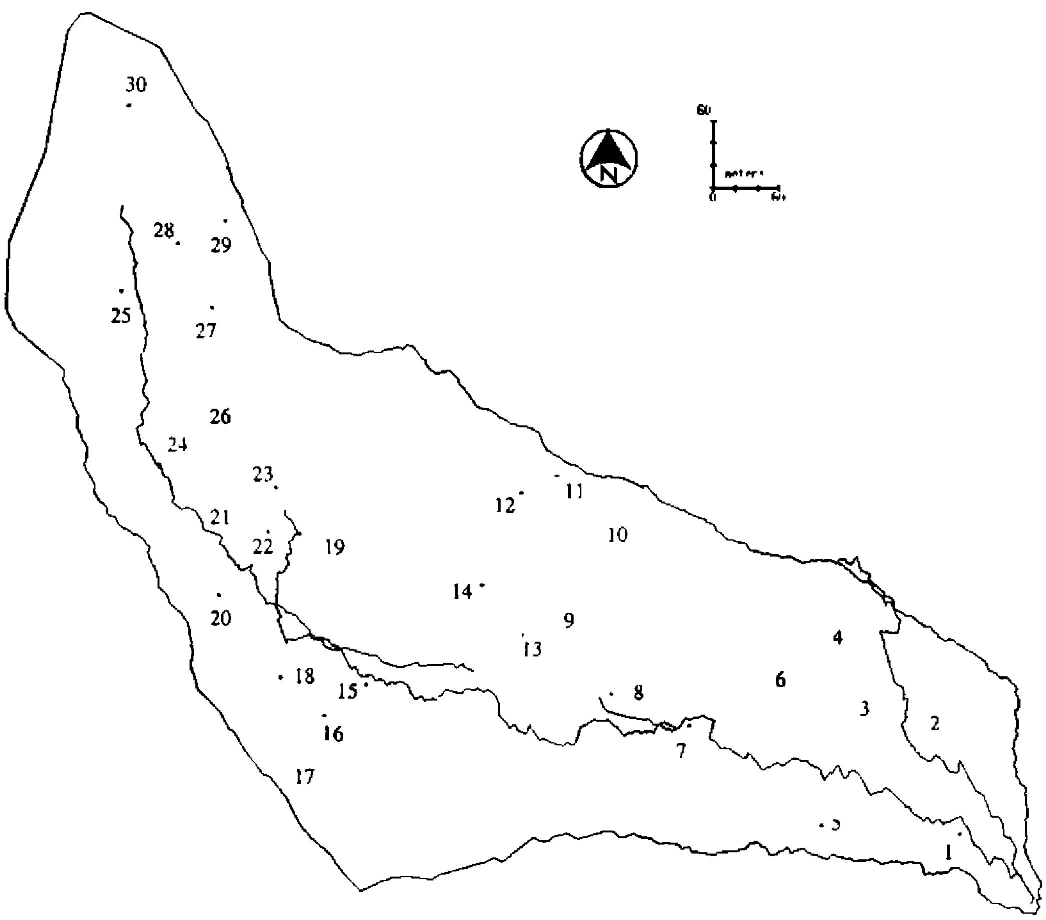

Figure 2. Location of the vegetation monitoring plots in Cadillac Brook watershed in Acadia National Park.

PRIMENet GIS database. Tables A-1 and A-2 in the appendix include the locations of the plots in Cadillac Brook and Hadlock Brook watersheds, respectively, based on GPS data. Tables A-3 and A-4 in the appendix include information about plot location based on distance and azimuth from nearby trails, the brooks, and other landmarks.

Plot Design

The FHM program plot design utilizes a cluster-plot design of four circular plots. This study at Acadia did not employ cluster-plots, but used individual plots of the same size and shape as an individual FHM subplot. Hence, the plot design was a 7.32-m radius circular plot (area = 1/60 ha) (Figure 4). In locations with adequate soil substrate, plot centers were permanently marked (National Park Service research permit ACAD99-24) with a 30-cm metal rod, which extended about 5 to 8 cm above the ground. The rod was topped with a yellow plastic cap inscribed with PRIMENET

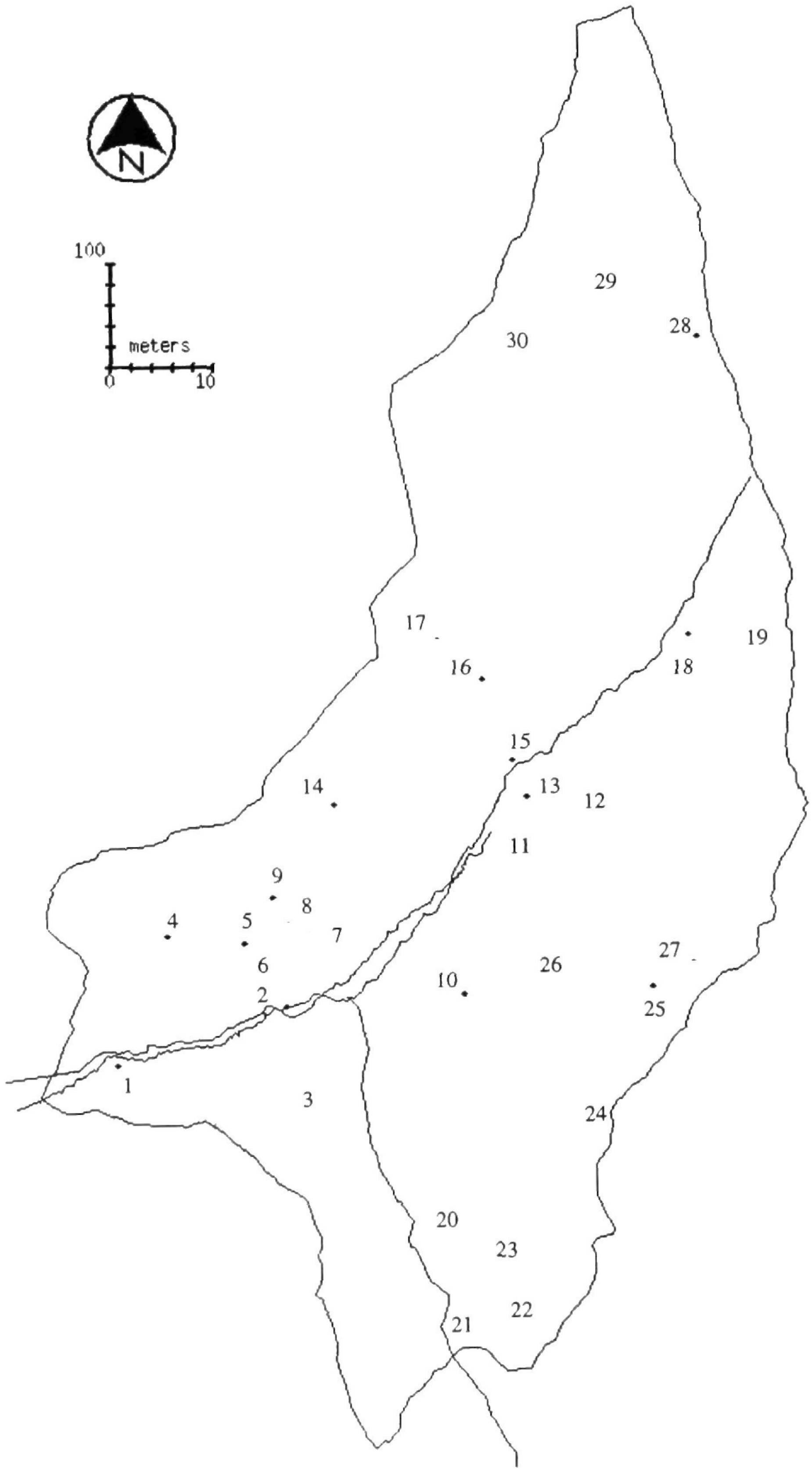

Figure 3. Location of the vegetation monitoring plots in Hadlock Brook watershed in Acadia National Park.

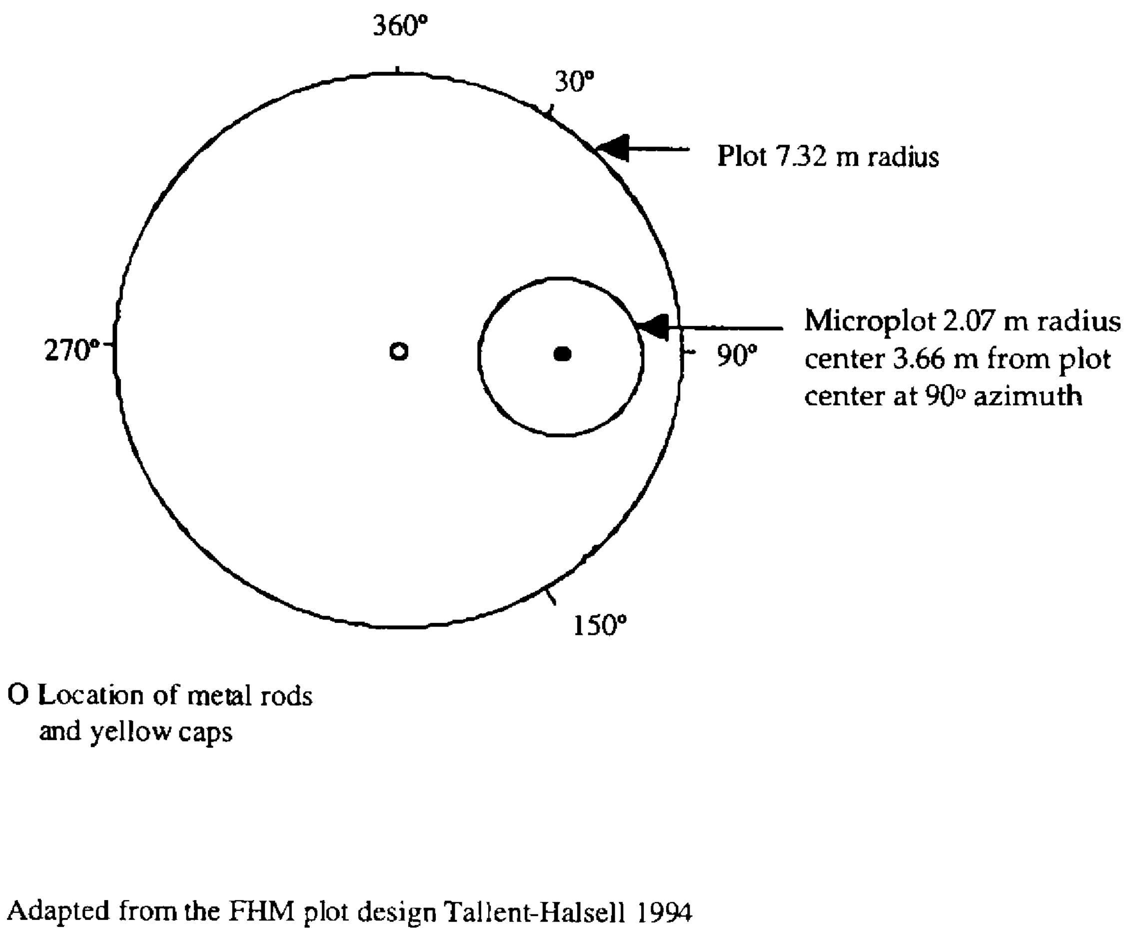

Figure 4. PRIMENet plot design for vegetation monitoring at Acadia National Park.

NPS 1999. If the plot was located on bare rock, then no rod was used (the location was recorded with GPS only). A tree tag (indicating the project name, year, watershed name, plot number, and tree number) was attached near the base of one tree at each plot. This tree was the first tree encountered (within the plot) when facing north from the plot center (moving clockwise around the plot as necessary to the first tree). If there were no trees in the plot the tag was attached to the rod at the plot center (plots without trees or a rod do not have a tag).

Within each plot was a 2.07-m fixed-radius microplot (area = 1/750 ha) located at 90° and 3.7 m from the plot center (Figure 4). (There was no permanent marking done for the microplots.)

Measurements Recorded

Within the 7.32-m-radius circular plot, measurements for the forest mensuration, crown condition classification, and damage and mortality indicators were recorded for the trees (diameter breast height [dbh] ≥12.7 cm), using the methods given in the Forest Health Monitoring (FHM) program manual (Tallent-Halsell 1994). Forest-type groups used to classify the forest vegetation are recognized by the Society of American Foresters (Eyre 1980). Basal area was assessed from the center of each plot using a 10-factor prism. Forest mensuration measurements were completed in all 30 plots in both watersheds; measurements included species name, location from the plot center (horizontal distance and azimuth), dbh, live or snag, and height (using a clinometer). Tables A-5 and A-6 in the appendix include the raw forest mensuration indicator data for the trees in Cadillac Brook and Hadlock Brook watersheds, respectively.

Crown condition and damage and mortality measurements were completed on nine plots in each watershed. In Cadillac Brook watershed there were only six deciduous and six coniferous forest-type plots (the balance were open areas or shrub communities). Measurements were recorded on the six deciduous plots. The coniferous forest-types were diverse and measurements were recorded from one plot in each coniferous forest-type (including *P. rubens, Thuja occidentalis,* and *Pinus rigida).* In Hadlock Brook watershed there were only two deciduous forest-type plots; measurements were recorded in both. There were 21 coniferous forest-type plots (all *P. rubens* or *P. rubens/Abies balsamea*). Measurements were recorded on seven of the coniferous plots, primarily in the lower portion of the watershed where soil depth and tree growth was greater than at the higher elevations. Crown condition measurements included crown class, live crown ratio, vigor, and width. Damage and mortality measurements included the location, damage type, and severity of up to three damages per tree (Table 1). Tables A-5 and A-6 in the appendix include the raw data for the crown condition classification, and damage and mortality indicators for the trees in Cadillac Brook and Hadlock Brook watersheds, respectively.

Nine site trees were selected in each watershed. Each site tree was located near, but not within, one of the same nine plots where crown condition and damages were recorded on the trees. (In the original FHM program site trees are located outside the plots because they are cored to assess age and all trees within the plots should not be affected in any way by the measurements.) Site trees were selected as representative of the overall trees within the area. Forest mensuration, crown condition, and damage and mortality assessments were completed on that tree. Table A-7 in the appendix

Table 1. FHM damage and mortality indicator: minimum thresholds for each combination of damage sign and the locations on the tree or sapling (shaded areas indicate that this location and damage sign is not a valid combination).

DAMAGE SIGN OR SYMPTOM listed in decreasing priority (FHM code #)	1st priority location	LOCATION ON THE TREE OF SAPLING (FHM code #)							last priority location
	roots & stump (1)	roots & lower bole (2)	lower bole (3)	lower & upper bole (4)	upper bole (5)	lower stem (6)	branches (7)	buds & shoots (8)	foliage (9)
canker (1)	20% of the circumference affected with a 0.91 m (3 ft) vertical section								
conks, fruiting bodies, & decay (2)	no minimum threshold								
open wounds (3)	20% of the circumference affected with a 0.91 m (3 ft) vertical section								
resinosis or gummosis (4)	20% of the circumference affected with a 0.91 m (3 ft) vertical section								
broken bole or roots >0.9m (3') from bole (11)	no minimum threshold								
brooms or roots or bole (12)	no minimum threshold								
broken or dead roots <0.9m (3') from bole (13)	<20% affected								
loss of apical dominance (21)						no minimum threshold			
broken or dead branches (22)							<20% affected		
excessive branching or brooms (23)							<20% affected		
damaged foliage or shoots (24)								≤30% of the buds, shoots or foliage <50% affected	
discoloration of foliage (25)									≤30% foliage <50% affected
other (31)	no minimum threshold		no minimum threshold			no minimum threshold		no minimum threshold	

(Severity codes vary by type of damage; for most damages 20–29% affected = code 2, 30–39% affected = code 3, etc.; other damages are '0' regardless of severity) Information adapted from Tallent-Halsell 1994 includes the raw data for the site trees in both Cadillac Brook and Hadlock Brook watersheds.

Forest mensuration, crown condition classification, and damage and mortality measurements were recorded for saplings (2.54 cm ≤ dbh < 12.7 cm) in the microplots found in the same nine plots (described previously) in each watershed in which crown condition and damage and mortality measurements were completed on the trees. Measurements recorded for the saplings included species name; location from the plot center (horizontal distance and azimuth); dbh; height (measured with a height pole); crown class, live crown ratio, and vigor; and location, damage type, and severity of up to three damages per sapling. Tables A-8 and A-9 in the appendix include the raw data for the saplings in Cadillac Brook and Hadlock Brook watersheds, respectively.

In the same microplots as the saplings, mensuration and crown condition data were recorded on tree seedlings (dbh < 2.54 cm and < 0.3 m tall). Measurements included species name, crown class, crown exposure, crown vigor, and seedling height. Tables A-10 and A-11 in the appendix include the raw data collected on the seedlings in Cadillac Brook and Hadlock Brook watersheds, respectively, for the forest mensuration and crown condition classification indicators. All tree, sapling, and seedling measurements in this study were recorded between June 21 and September 2, 2000.

Foliar Analysis

Foliar chemical analysis procedures used at Acadia were similar to those used by White (1996) at BBWM. Twenty samples of *Acer rubrum* (red maple) leaves and *Picea rubens* (red spruce) needles were collected from each watershed at Acadia for a total of forty samples per species. (Several tree species have been sampled at BBWM; however, these two species were the only ones in common and in a high enough abundance in both Acadia and BBWM to allow for comparison of the two study areas). Samples were collected at compass points radiating out from the centers of selected plots (those containing the appropriate tree species) and/or along a transect between the selected plots. Tables A-12 and A-13 in the appendix include the collection locations of the *A. rubrum* and *P. rubens* foliar samples, respectively.

Leaves were collected using a pruning saw at a height no taller than 9 m. All leaves were located on the outside edges of lateral branches (ensuring they were sun leaves) on the south side of codominant trees. *Acer rubrum* samples were collected in the first week of September of 1999. The timing was late enough that the leaves were fully developed and functional but early enough so that physiological changes leading to fall senescence had not yet occurred. Each sample consisted of 30 visually healthy leaves (e.g., no signs of insect damage) with no signs of fall coloration. *Picea rubens* needles were collected in the last week of October 1999. Each sample consisted of several tips of the current year's needles only. Again, the timing was late enough in the growing season that the needles were fully developed. (The timing for sample collection at Acadia was the same as the timing for sample collection at BBWM by White [1996].)

Prior to chemical analysis, the collected leaf samples were dried at a temperature of approximately 65 °C and ground in a Wiley mill to 40 mesh. The Wiley mill was vacuumed between samples to reduce potential of sample contamination. Chemical analyses were completed by the Maine Agricultural and Forest Experiment Station Analytical Laboratory at the University of Maine in Orono. Non-volatile nutrients were processed using a dry ash mineral analysis method that included plasma emission (ICP) (Kalra and Maynard 1991; Moyse and Fernandez 1987). Total N was determined with Leco CN 2000 total-nitrogen equipment following combustion of the dried leaves (USDA 1996). Tables A-14 and A-15 in the appendix include the raw foliar chemistry data from the *A. rubrum* and *P. rubens* leaves/needles, respectively.

Statistical Analysis

Hypotheses:

1. There was no difference in *A. rubrum* foliar chemistry between Cadillac Brook and Hadlock Brook watersheds.
2. There was no difference in *P. rubens* foliar chemistry between Cadillac Brook and Hadlock Brook watersheds.

All statistical analyses were accomplished using the SAS® program JMP® (SAS 1998). Statistical analysis included one-way analysis of variance (ANOVA) with alpha = 0.05. ANOVA assumptions were tested using Levene's test for homogeneity of variances and Shapiro-Wilk W test for normality. To meet the assumptions, some of the foliar chemistry data were transformed. For *A. rubrum* both assumptions were met using raw data for N, phosphorus (P), and copper (Cu); log transformed data for calcium (Ca), potassium (K), magnesium (Mg), aluminum (Al), and zinc (Zn); square root transformed data for boron (B); l/square root transformed data for cadmium (Cd); and reciprocal transformed for iron (Fe). Although the manganese (Mn) data could not be normalized, the raw data was used for analyses. For *P. rubens* the assumptions were met using raw data for N, K, Mg, Al, and lead (Pb); log transformed data for Ca, and Cu; and reciprocal transformed for P, Fe, and Zn. Raw data were used for B and log transformed data for Mn; although the data were homogeneous, the latter could not be normalized.

RESULTS

Cadillac Brook Watershed

Approximately 27% of Cadillac Brook watershed was "open/shrub," mostly bare rock surfaces often with shrubs in the surrounding vicinity (Table 2). Thirty-three percent of the watershed was mixed "scrub/shrub" communities, dense with low-growing vegetation and various shrub species. Twenty percent of the watershed was deciduous (or hardwood) forest; the dominant tree species was *Betula papyrifera* (paper birch) with *Populus grandidentata* (bigtooth aspen), *Acer pensylvanicum* (striped maple), and *Fraxinus americana* (white ash) (Table 3). The remaining 20% of the watershed was coniferous (or softwood) forest; the dominant tree species were *P. rubens* and *Abies balsamea* (balsam fir) with one localized area of *Pinus rigida* (pitch pine) and another dense area of *Thuja occidentalis* (northern white cedar). In the deciduous forest areas in Cadillac Brook watershed approximately 9% of the trees recorded were snags (dead standing trees); approximately 10% of the trees in the coniferous forest areas were snags.

The average tree dbh for the live trees in the deciduous forest areas in Cadillac watershed was 16.8 cm; the range was 12.8 to 30.4 cm (Table 4). The average tree height was approximately 14 m. The average live crown ratio was approximately 43%. Ninety percent of the trees in the deciduous forest in Cadillac were in the codominant crown class; the balance were in the intermediate crown class (Table 5). Overall almost two-thirds of the trees had high crown vigor.

In determining the first damage per tree, approximately 79% of the trees in the deciduous forest areas in Cadillac showed no signs or symptoms of damage (Table 6). The most common damage that was recorded in the first assessment was the presence of conks, fruiting bodies, or other indicators of advanced decay, present on approximately 14% of the trees. Other damages that occurred infrequently (on about 2% of the trees) in the first assessment included cankers, loss of apical dominance or dead terminal leader,

Table 2. Vegetation types within the plots in Cadillac Brook and Hadlock Brook watersheds at Acadia National Park in 1999.

Plot#	Vegetation types	Descriptions by individual plot	Basal area sq m/ha	
Cadillac Brook Watershed				
8	open/shrub	with lots of blueberry and other shrubs (plus a couple saplings in area)	0	
9	open/shrub	with one white cedar (red spruce, paper birch, striped maple, and red maple)	0	
15	open/shrub	very open (some birch, red spruce, and cedar in surrounding area)	4.6	27% of the total watershed
16	open/shrub	rock face (red oak, shrubby birch, other shrubs, and red spruce in surrounding area)	9.2	
20	open/shrub	with shrubby birch and other shrubs (some red spruce in surrounding area)	0	
22	open/shrub	lots of shrubs (some red spruce and cedar saplings in area)	0	
27	open/shrub	with lots of shrubs	0	
28	open/shrub	with shrubby birch and other shrubs (some red spruce in surrounding area)	0	
11	mixed scrub/shrub	lots of shrubby birch (some red spruce, cedar, and pitch pine in surrounding area)	4.6	
12	mixed scrub/shrub	lots of shrubby birch, blueberry, and other shrubs	4.6	
14	mixed scrub/shrub	lots of shrubby birch (balsam fir, red maple, and red oak in surrounding area)	13.8	
17	mixed scrub/shrub	lots of shrubby birch (some balsam fir, cedar, and red oak in surrounding area)	18.4	33% of the total watershed
18	mixed scrub/shrub	lots of shrubby birch (some cedar and red spruce in the surrounding area)	9.2	
19	mixed scrub/shrub	moderately open with lots of shrubs (some cedar and red spruce surrounding)	4.6	
21	mixed scrub/shrub	lots of thick shrubby birch (some red maple, cedar, and red spruce surrounding)	0	
23	mixed scrub/shrub	with lots of shrubs including shrubby birch (balsam fir and red spruce in area)	4.6	
26	mixed scrub/shrub	with balsam fir and shrubs (some red spruce in the area)	0	
29	mixed scrub/shrub	lots of shrubby birch (some small red spruce, northern white cedar, and red oak)	0	
1	hardwood (decid. forest)	aspen (with beech, ash, and striped maple)	50.5	
2	hardwood (decid. forest)	paper birch (with bigtoothed aspen, yellow birch, and red spruce)	23.0	20% of the total watershed
3	hardwood (decid. forest)	paper birch (with white ash and striped maple)	41.3	
4	hardwood (decid. forest)	paper birch (with lots of striped maple and some sugar maple)	36.7	
5	hardwood (decid. forest)	paper birch (with red maple, striped maple, and yellow birch)	4.6	
6	hardwood (decid. forest)	paper birch (with bigtoothed aspen, northern white cedar, and red oak)	27.6	

Table 2. Continued.

Plot#	Vegetation types	Descriptions by individual plot	Basal area sq m/ha	
7	softwood (conif. forest)	northern white cedar	59.7	
10	softwood (conif. forest)	pitch pine	18.4	20% of
13	softwood (conif. forest)	red spruce/balsam fir (also striped maple and paper birch)	13.8	the
24	softwood (conif. forest)	red spruce/balsam fir	18.4	total
25	softwood (conif. forest)	balsam fir	36.7	watershed
30	softwood (conif. forest)	red spruce	27.6	
Hadlock Brook watershed				
4	open/shrub	with red spruce in surrounding area	0	13%
5	open/shrub	with red spruce and white pine in surrounding area	4.6	of the
22	open/shrub	with shrubs (red spruce and white pine in surrounding area)	0	total
28	open/shrub	with only a few small shrubs	0	watershed
25	mixed scrub/shrub	with lots of shrubs (scattered sapling size and stunted/open-ground red spruce)	0	10% of
27	mixed scrub/shrub	with lots of small shrubs (scattered short red spruce also white pine & mt. ash)	0	the total
29	mixed scrub/shrub	with lots of small shrubs (and a few scattered very small red spruce in area)	0	watershed
1	hardwood (decid. forest)	maple/beech/birch	23.0	7% of the
2	hardwood (decid. forest)	maple/beech/birch	36.7	total watershed

Table 2. Continued.

Plot#	Vegetation types	Descriptions by individual plot	Basal area sq m/ha	
3	softwood (conif. forest)	red spruce	27.6	
6	softwood (conif. forest)	red spruce	55.1	
7	softwood (conif. forest)	red spruce	45.9	
8	softwood (conif. forest)	red spruce	23.0	
9	softwood (conif. forest)	red spruce	32.1	
10	softwood (conif. forest)	red spruce	36.7	
11	softwood (conif. forest)	red spruce/balsam fir	18.4	
12	softwood (conif. forest)	red spruce	36.7	
13	softwood (conif. forest)	red spruce/balsam fir	32.1	70%
14	softwood (conif. forest)	red spruce/balsam fir	18.4	of the
15	softwood (conif. forest)	red spruce/balsam fir	41.3	total
16	softwood (conif. forest)	red spruce/balsam fir (yellow birch and striped maple in surrounding area)	41.3	watershed
17	softwood (conif. forest)	red spruce	13.8	
18	softwood (conif. forest)	red spruce	32.1	
19	softwood (conif. forest)	red spruce/balsam fir (American mountain ash near the plot)	23.0	
20	softwood (conif. forest)	red spruce/balsam fir (yellow birch and striped maple in surrounding area)	13.8	
21	softwood (conif. forest)	red spruce/balsam fir (balsam fir in understory along with red spruce regen.)	32.1	
23	softwood (conif. forest)	red spruce (somewhat open-ground trees)	27.6	
24	softwood (conif. forest)	red spruce/balsam fir (yellow birch, cedar, white pine, and red maple in the area)	23.0	
26	softwood (conif. forest)	red spruce (yellow birch and red maple in the surrounding area)	32.1	
30	softwood (conif. forest)	red spruce/balsam fir (r. maple, white cedar, Am. mt. ash, & white pine in area)	9.2	

Table 3. Species composition of trees, saplings, and seedlings, within the deciduous and coniferous forest-types in Cadillac Brook and Hadlock Brook watersheds in Acadia National Park in 1999.

		Cadillac Brook		Hadlock Brook	
		Forest-types			
Latin name	Common name	Deciduous	Coniferous	Deciduous	Coniferous
a) Tree Species		%			
Abies balsamea	balsam fir	0	19	0	3
Acer pensylvanicum	striped maple	12	0	0	0
Acer rubrum	red maple	2	4	8	4
Acer saccharum	sugar maple	5	0	15	0
Betula alleghaniensis	yellow birch	2	3	39	11
Betula papyrifera	paper birch	48	1	0	0
Betula populifolia	gray birch	0	1	0	0
Fagus grandifolia	American beech	2	0	23	0
Fraxinus americana	white ash	7	0	0	0
Larix laricina	tamarack	0	0	0	1
Picea rubens	red spruce	5	24	15	80
Pinus rigida	pitch pine	0	8	0	0
Pinus strobus	eastern white pine	0	0	0	1
Populus grandidentata	bigtooth aspen	17	0	0	0
Thuja occidentalis	northern white cedar	0	39	0	1
b) Saplings Species:					
Acer pensylvanicum	striped maple	65	(incomplete	0	0
Amelanchier sp.	serviceberry	0	information)	0	14
Betula alleghaniensis	yellow birch	0		0	29
Betula papyrifera	paper birch	24		0	0
Fagus grandifolia	American beech	6		50	0
Fraxinus americana	white ash	6		0	0
Picea rubens	red spruce	0		50	57
c) Seedlings Species:					
Abies balsamea	balsam fir	4	(incomplete	2	7
Acer pensylvanicum	striped maple	81	information)	27	14
Acer rubrum	red maple	4		0	0
Betula alleghaniensis	yellow birch	0		0	7
Fagus grandifolia	American beech	11		11	0
Picea rubens	red spruce	0		59	68
Pinus strobus	eastern white pine	0		0	4

Table 4. Mean, median, range, standard deviation, and standard error (by forest-type) for tree dbh, height, live crown ratio, and tree crown width (two perpendicular measurements) in Cadillac and Hadlock watersheds at Acadia National Park in 1999.

Tree Measurements	N	Mean	Median	Minimum	Maximum	Stand. Dev.	Stand. Error
a) Cadillac Brook: Deciduous forest-types							
tree dbh (cm)	42	16.8	15.8	12.8	30.4	4.1	0.6
tree height (m)	42	14.1	14.8	5.2	19.2	2.9	0.4
tree live crown ratio (%)	42	43.2	40.0	20.0	90.0	14.7	2.3
tree crown width (m)	42	4.8	4.7	2.5	8.1	1.1	0.2
crown width (m) at 90°[1]	42	3.8	3.8	1.2	6.1	1.1	0.2
b) Hadlock Brook: Deciduous forest-types							
tree dbh (cm)	13	26.3	25.0	14.7	53.7	11.0	3.0
tree height (m)	12	15.0	15.7	7.8	19.5	3.4	1.0
tree live crown ratio	13	45.8	40.0	20.0	75.0	19.3	5.4
tree crown width (m)	13	8.4	7.4	4.5	18.3	3.8	1.0
crown width (m) at 90°[1]	13	6.9	6.8	3.5	13.0	2.7	0.7
c) Hadlock Brook: Coniferous forest-types							
tree dbh (cm)	204	22.9	20.8	13.0	50.5	8.1	0.6
tree height (m)	58	15.9	16.0	4.4	24.9	3.8	0.5
tree live crown ratio (%)	58	40.9	40.0	10.0	90.0	20.3	2.7
tree crown width (m)	58	4.8	4.6	2.3	10.4	1.6	0.2
crown width (m) at 90°[1]	58	4.0	3.8	1.7	9.8	1.5	0.2

[1]two crown widths were measured per tree, the second at a perpendicular (90°) angle to the first

Table 5. Percentage of trees, saplings, and seedlings grouped by crown vigor (high, medium, or low) within the three crown classes in the deciduous forest-type in Cadillac Brook watershed and the deciduous and coniferous forest-types in Hadlock Brook watershed at Acadia National Park in 1999.

Crown class:	Open grown			Dominant			Codominant			Intermediate			Overtopped		
Crown vigor	High	Medium	Low	High	Medium	Low	High	Medium	Low	High	Medium	Low	High	Medium	Low
	%														
a) Cadillac Brook: Deciduous forest-types															
trees	0	0	0	0	0	0	62	21	7	2	5	2	0	0	0
saplings	0	0	0	0	0	0	6	0	6	24	18	6	35	6	0
seedlings	0	0	0	0	0	0	0	0	0	0	0	0	56	18	26
b) Hadlock Brook: Deciduous forest-types															
trees	0	0	0	8	8	0	23	46	15	0	0	0	0	0	0
saplings	0	0	0	0	0	0	0	0	0	0	50	0	0	50	0
seedlings	0	0	0	0	0	0	0	0	0	0	0	0	23	45	32
c) Hadlock Brook: Coniferous forest-types															
trees	0	2	0	5	2	0	21	35	10	5	14	7	0	0	0
saplings	0	0	0	0	0	0	29	0	0	0	0	0	43	14	14
seedlings	0	0	0	0	0	0	0	0	0	0	0	0	46	29	25

Table 6. Percentage of damage signs and symptoms recorded for trees, all species combined, within the deciduous forest-type in Cadillac Brook watershed and deciduous and coniferous forest-types in Hadlock Brook watersheds at Acadia National Park in 1999.

Damage sign or symptom (listed in FHM priority)	1st Damage Sign	2nd Damage Sign	3rd Damage Sign
	----------	%	----------
a) Cadillac Brook: Trees in the deciduous forest-types			
no damage	78.6	95.2	100
cankers	2.4	0	0
conks, fruiting bodies, & decay	14.3	2.4	0
open wounds	0	0	0
resinosis or gummosis	0	0	0
broken bole or roots	0	0	0
> 0.9m (3') from bole	0	0	0
loss of apical dominance	2.4	0	0
broken or dead branches	2.4	2.4	0
damaged foliage or shoots	0	0	0
discoloration of foliage	0	0	0
other	0	0	0
b) Hadlock Brook: Trees in the deciduous forest-types			
no damage	23.1	76.9	92.3
cankers	30.8	7.7	7.7
conks, fruiting bodies, & decay	15.4	0	0
open wounds	7.7	0	0
resinosis or gummosis	7.7	0	0
broken bole or roots	0	0	0
> 0.9m (3') from bole	0	0	0
loss of apical dominance	0	15.4	0
broken or dead branches	15.4	0	0
damaged foliage or shoots	0	0	0
discoloration of foliage	0	0	0
other	0	0	0
c) Hadlock Brook: Trees in the coniferous forest-types			
no damage	53.4	87.9	100
cankers	13.8	0	0
conks, fruiting bodies, & decay	3.4	1.7	0
open wounds	3.4	0	0
resinosis or gummosis	3.4	1.7	0
broken bole or roots	0	0	0
> 0.9m (3') from bole	0	0	0
loss of apical dominance	1.7	3.4	0
broken or dead branches	20.7	5.2	0
damaged foliage or shoots	0	0	0
discoloration of foliage	0	0	0
other	0	0	0

and broken or dead branches within the live crown area. In determining a second damage per tree, more than 95% had no signs or symptoms of damage; the balance included signs of advanced decay and broken or dead branches.

Within the deciduous forest-types in Cadillac the dominant sapling species were *A. pensylvanicum* and *B. papyrifera;* the dominant seedling species were *A. pensylvanicum* and *Fagus grandifolia* (American beech) (Table 3). Overall 78% of the saplings had no signs or symptoms of damage (Table 7). The most common damage recorded on saplings was broken or dead branches followed by open wounds and cankers.

All tree seedlings were in the overtopped crown class; within this class 56% of the seedlings had high crown vigor, 18% had medium crown vigor, and 26% had low crown vigor (Table 5). Overall, 7% of the seedlings received direct light from above and some from the sides (high light levels) (Table 8). Forty-eight percent of the seedlings were exposed to direct light from above but relatively little from the sides (moderate light levels). Thirty percent of the seedlings received limited direct overhead light and 15% grew in very heavily shaded areas (poor light levels).

Hadlock Brook Watershed

Hadlock Brook watershed was approximately 13% open/shrub, mostly bare rock surfaces often with shrubs in the surrounding vicinity, and 10% mixed scrub/shrub areas, dense with low growing vegetation and various shrub species (Table 2). Seven percent of the watershed was deciduous forest; the dominant tree species were *B. alleghaniensis, F. grandifolia,* and *A. saccharum* (sugar maple) (Table 3). The majority of Hadlock Brook watershed, 70%, was conifer forest; the dominant tree species was *P. rubens* with some *B. alleghaniensis.* In the deciduous forest areas in Hadlock Brook watershed approximately 24% of the trees recorded were snags (dead standing trees); approximately 14% of the trees in the coniferous forest areas were snags.

In the deciduous forest areas in Hadlock watershed the average tree dbh for the live trees was 26.3 cm; the range was 14.7 to 53.7 cm (Table 4). The average tree height was approximately 15 m. The average live crown ratio was approximately 46%. Sixteen percent of the trees in the deciduous forest in Hadlock were in the dominant crown class; the majority (84%) was in the codominant crown class (Table 5). Approximately one-third of the trees had high crown vigor and more than half had moderate crown vigor.

Table 7. Percentage of damage signs and symptoms recorded for saplings, all species combined, within the deciduous forests in Cadillac Brook watershed and deciduous and coniferous forest-types in Hadlock Brook watersheds at Acadia National Park in 1999.

Damage sign or symptom (listed in FHM priority)	1st Damage Sign	2nd Damage Sign	3rd Damage Sign
		%	
a) Cadillac Brook: Saplings in the deciduous forest-types			
no damage	76.5	100	100
cankers	5.9	0	0
conks, fruiting bodies, & decay	0	0	0
open wounds	5.9	0	0
resinosis or gummosis	0	0	0
broken bole or roots	0	0	0
> 0.9m (3') from bole	0	0	0
loss of apical dominance	0	0	0
broken or dead branches	11.8	0	0
damaged foliage or shoots	0	0	0
discoloration of foliage	0	0	0
other	0	0	0
b) Hadlock Brook: Saplings within the deciduous forest-types			
no damage	0	50.0	50.0
cankers	50.0	50.0	50.0
conks, fruiting bodies, & decay	0	0	0
open wounds	0	0	0
resinosis or gummosis	0	0	0
broken bole or roots	0	0	0
> 0.9m (3') from bole	0	0	0
loss of apical dominance	0	0	0
broken or dead branches	50.0	0	0
damaged foliage or shoots	0	0	0
discoloration of foliage	0	0	0
other	0	0	0
c) Hadlock Brook: Saplings within the coniferous forest-types			
no damage	57.1	100	100
cankers	0	0	0
conks, fruiting bodies, & decay	14	0	0
open wounds	0	0	0
resinosis or gummosis	0	0	0
broken bole or roots	0	0	0
> 0.9m (3') from bole	0	0	0
loss of apical dominance	0	0	0
broken or dead branches	28.6	0	0
damaged foliage or shoots	0	0	0
discoloration of foliage	0	0	0
other	0	0	0

Table 8. Percentage of seedlings with crowns exposed to high, moderate, limited, or poor direct overhead sunlight in Cadillac Brook watershed and Hadlock Brook watershed at Acadia National Park in 1999.

	Overhead Sunlight			
	High	Moderate	Limited	Poor
	%			
Cadillac Brook: deciduous forest-types	7	48	30	15
Hadlock Brook: deciduous forest-types	9	21	18	52
Hadlock Brook: coniferous forest-type	4	89	7	0

In the coniferous forest areas in Hadlock watershed the average tree dbh was approximately 23 cm (Table 4). The dbh ranged between 13 and 50.5 cm. The average tree height was approximately 16 m. The average live crown ratio was approximately 41%. Two percent of the trees in the conifer areas were open grown (spread far apart from each other) and seven percent were in the dominant crown class. Two-thirds were codominant and around one-quarter were in the intermediate crown class (Table 5). Thirty-one percent had high crown vigor and 53% had medium crown vigor.

In determining the first damage per tree, approximately 23% of the trees in the deciduous forest areas in Hadlock showed no signs or symptoms of damage (Table 6). The most common damage that was recorded in the first assessment was the presence of cankers on approximately 31% of the trees. Approximately 15% of the trees had conks, fruiting bodies or other indicators of advanced decay and another 15% had broken or dead branches within the live crown. The balance of the damage signs present included open wounds and resinosis or gummosis. In determining a second damage per tree, approximately 77% had no further signs or symptoms of damage; the balance of the trees had either loss of apical dominance or cankers present. Ninety-two percent of the trees had no signs or symptoms present indicating a third damage.

Within the coniferous forest areas, approximately 53% of the trees had no signs or symptoms of a first damage (Table 6). The most common first damage sign on approximately 20% of the trees was broken or dead branches within the live crown. Other damage signs present in the first assessment included cankers; conks, fruiting bodies and indicators of advanced decay; open wounds; resinosis or gummosis; and loss of apical dominance or terminal leader. In determining a second damage per tree, approximately 88% had no further signs or symptoms of damage. The balance of the trees had broken or dead branches, loss of apical dominance, advanced decay, or resinosis or gummosis. None of the trees had any signs or symptoms of a third damage.

Within the deciduous forest-types in Hadlock the dominant sapling species were *P. rubens* and *F. grandifolia* (Table 3). Common damage signs and symptoms on saplings in the deciduous forest-types were broken or dead branches, and cankers (Table 7). Within the coniferous forest-types *P. rubens* and *B. alleghaniensis* were the dominant sapling species (Table 3). About 57% of the saplings had no damage signs or symptoms (Table 7). Broken or dead branches was the most common damage sign on saplings, followed by evidence of conks, fruiting bodies, or decay.

In the deciduous forest-type the dominant seedling species were *P rubens, A. pensylvanicum,* and *F. grandifolia* (Table 3). In the coniferous forest-type the dominant seedling species were *P. rubens* and *A. pensylvanicum.* All of the seedlings in Hadlock, in both the deciduous and coniferous forest-types, were in the overtopped crown class (Table 5). In the deciduous forest-type 23% of the seedlings had high crown vigor, 45% had medium and 32% had low crown vigor. This contrasts with the coniferous forest-type in which 46% of the seedlings had high crown vigor, 29% had medium and 25% had low crown vigor. Fifty-two percent of the seedlings in the deciduous forest-type area in Hadlock were growing in very heavy shade (poor light levels) (Table 8). The other half of the seedlings were primarily growing in areas exposed to direct light from above but with relatively little from the sides (moderate light levels) or in limited direct overhead light. Eighty-nine percent of the seedlings in the coniferous forest-type areas were exposed to direct light from above but relatively little from the sides (moderate light levels).

Foliar Chemical Analyses

Analyses of *A. rubrum* foliage showed statistically significant differences in foliar chemistry between Cadillac Brook and Hadlock Brook watersheds. Cadillac Brook had significantly higher levels of Ca (p=0.005), Cu (p=0.003), Mn (p<0.0001), Zn (p=0.01), and Cd (p=0.02) (Table 9). The only element higher in Hadlock Brook was Al (p=0.045). Analysis of *A. rubrum* foliage indicated no significant differences between Cadillac Brook and Hadlock Brook watersheds for N (p=0.5), K (p=0.4), Mg (p=0.7), B (p=0.1), or Fe (p=0.8).

Table 9. Mean and standard deviation of nutrient concentrations in *Acer rubrum* and *Picea rubens* in Cadillac Brook watershed and Hadlock Brook watershed in Acadia National Park in 1999 (n=20; untransformed data), and in East Bear and West Bear watersheds at the BBWM in 1994.

			Acadia National Park			Bear Brook Watershed in Maine	
			Cadillac	Hadlock		East Bear	West Bear
			Mean Std. Deviation	Mean Std. Deviation		Mean Std. Deviation	Mean Std. Deviation
a) *Acer rubrum*							
	N	(%)	1.75 ± 0.3	1.80 ± 0.2	**	1.83 ± 0.2	2.14 ± 0.1
*	Ca	(mg/kg)	6509.7 ± 2949.4	4482.1 ± 1576.5		5700.0± 848.0	6060.0 ± 732.0
	K	(mg/kg)	6377.4 ± 1458.4	7061.7 ± 2338.5		7380.0 ± 488.0	6180.0 ± 2100.0
	Mg	(mg/kg)	1097.7 ± 278.0	1138.3 ± 443.6		1250.0 ± 309.0	1550.0 ± 265.0
	P	(mg/kg)	937.9 ± 158.0	841.5 ± 143.8		1090.0± 142.0	1220.0 ± 76.3
*	Al	(mg/kg)	8.1 ± 5.0	10.8 ± 5.5	**	10.3 ± 1.0	13.7 ± 3.4
	B	(mg/kg)	34.5 ± 13.1	28.6 ± 17.8		33.7 ± 6.8	33.8 ± 8.2
*	Cu	(mg/kg)	7.3 ± 2.5	4.9 ± 2.2		6.4 ± 2.5	5.6 ± 1.2
	Fe	(mg/kg)	50.1 ± 29.5	49.2 ± 17.4		44.6 ± 10.1	53.6 ± 9.8
*	Mn	(mg/kg)	362.8 ± 116.0	144.7 ± 160.7	**	386.0 ± 159.0	782.0 ± 232.0
*	Zn	(mg/kg)	37.8 ± 15.0	27.5 ± 7.8		24.0 ± 7.0	28.5 ± 6.8
*	Cd	(ug/kg)	110.7 ± 80.0	73.2 ± 13.9			
	Pb	(mg/kg)	< 0.5	< 0.5			
b) *Picea rubens*							
*	N	(%)	1.01 ± 0.1	1.10 ± 0.1	**	1.09 ± 0.1	1.19 ± 0.1
*	Ca	(mg/kg)	2352.3 ± 978.5	1626.4 ± 466.1		1690.0 ± 504.0	1780.0 ± 541.0
*	K	(mg/kg)	5608.2 ± 944.9	7221.3 ± 894.3	**	7710.0 ± 1260.0	7050.0 ± 1450.0
	Mg	(mg/kg)	1025.1 ± 169.8	964.3 ± 115.7		704.0 ± 106.0	722.0 ± 136.0
	P	(mg/kg)	851.8 ± 111.9	875.5 ± 108.3		1090.0 ± 108.0	1130.0 ± 165.0
	Al	(mg/kg)	39.6 ± 15.6	45.3 ± 19.3		56.5 ± 14.4	55.5 ± 18.2
	B	(mg/kg)	16.3 ± 2.5	15.8 ± 4.5		14.9 ± 3.9	16.5 ± 3.9
	Cu	(mg/kg)	2.9 ± 0.3	3.1 ± 0.4		3.8 ± 0.8	3.9 ± 0.6
*	Fe	(mgtkg)	28.9 ± 8.3	22.8 ± 3.3		26.4 ± 4.8	25.6 ± 3.5
*	Mn	(mg/kg)	380.1 ± 189.7	234.9 ± 54.0		938.0 ± 345.0	936.0 ± 453.0
*	Zn	(mg/kg)	33.4 ± 28.6	21.5 ± 5.1		17.5 ± 3.6	16.5 ± 4.6
	Cd	(ug/kg)	• < 51.5	< 51.5			
	Pb	(mg/kg)	3.1 ± 0.7	2.9 ± 0.6			

* indicates statistically significant differences between Cadillac Brook and Hadlock Brook watersheds at $p < 0.05$; ** indicates differences between East Bear Brook and West Bear Brook watersheds. Information on East Bear and West Bear watersheds obtained from White (1996)

Analyses of *P. rubens* foliage also showed statistically significant differences in foliar chemistry between Cadillac Brook and Hadlock Brook watersheds. Cadillac Brook had significantly higher levels of Ca ($p=0.002$), Fe ($p=0.01$), Mn ($p=0.01$) and Zn ($p=0.04$) (Table 9). Hadlock Brook had significantly higher levels of N ($p=0.003$) and K ($p<0.0001$). Analysis of *P. rubens* foliage indicated no significant differences between Cadillac Brook and Hadlock Brook watersheds for Mg ($p=0.2$), P ($p=0.5$), Al ($p=0.3$), B ($p=0.7$), Cu ($p=0.08$), or Pb ($p=0.4$).

DISCUSSION

Disturbance History and Vegetation Patterns at Acadia

On a landscape scale the impacts of wildfires are generally patchy, more heavily affecting some areas and "skipping over" others (Pyne et al. 1996). The uneven impacts are sometimes due to the presence of streams, lakes, roads, steep terrain breaks, or exposed bare rock surfaces, which may function as firebreaks (Grimm 1984). On MDI the extensive wildfire in 1947 affected the landscape in a typically patchy manner. Portions of the Cadillac Brook watershed were affected by the 1947 wildfire. Charcoal deposits in the paleoecological records compiled by Schauffler et al. (unpublished) demonstrate a history of the occurrence of fires in Cadillac Brook watershed. In contrast, the 1947 fire did not affect the Hadlock Brook watershed. This is evidenced in the mature forest structure of both the deciduous and coniferous forest-types. In Cadillac watershed many of the trees in the deciduous forest areas became established following the 1947 wildfire and subsequent salvaging of damaged trees that opened up the overstory canopy in this area more than 50 years ago.

The mosaic of vegetation types in Cadillac watershed (Figure 5) and, to a lesser degree, Hadlock (Figure 6) watershed reflected a diverse landscape. The mid-to-higher elevations in both watersheds were very open exposed rock surfaces or open/shrub areas with little vegetation. The vegetation that was present included small shrubs and herbaceous plants growing primarily in the cracks and crevices between the rocks where enough substrate had accumulated to support plant growth. Interspersed with the open/shrub areas were scrub/shrub areas dominated by shrub species and herbaceous plants with a few scattered trees (e.g., *P. rubens* or *T. occidentalis*). The trees were generally stunted in growth form (average dbh 16 cm and height 4.7 m) probably due to the minimal soil substrate and resulting limited nutrient resources and water availability. During

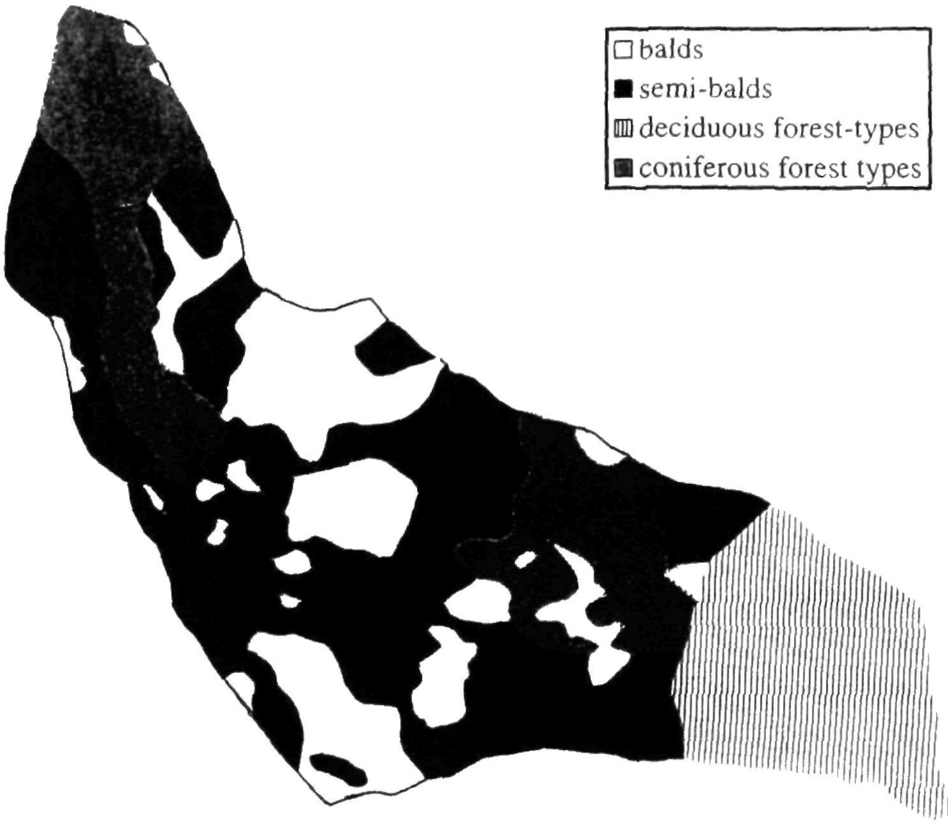

Figure 5. Vegetation types within Cadillac Brook watershed in Acadia National Park (based on aerial photographs ground-truthed with plot data).

inclement weather oftentimes a cloud cover engulfs these high elevation or summit areas in a very moist, dense fog. Overall open/ shrub and scrub/shrub areas combined made up about 60% of Cadillac watershed and about 23% of Hadlock watershed (Table 2).

The dominant tree, sapling, and seedling species and the extent of forest vegetation in Cadillac and Hadlock watersheds were different (Table 3). The majority of Hadlock watershed (70%) was a combination of *P. rubens* and *P. rubens / A. balsamea* forest-types (Table 2). There was a relatively small area of deciduous forest on the south side of the stream in the lower portion of Hadlock watershed (Figure 6); this was *A. saccharum / F. grandifolia / B. alleghaniensis* forest-type. Within Cadillac watershed there were several different deciduous and coniferous forest-types. The lower portion of Cadillac watershed was *B. papyrifera* forest-type (Figure 5). The northern edge of this forest-type was primarily delineated by a steep rock cliff and/or sections of boulder-sized rocks (deposited from earlier rockslides). Immediately above the rock cliff on a relatively flat plateau (where the stream widens out) was pocket of *T. occidentalis* forest-type. Moist habits such as this are typical of

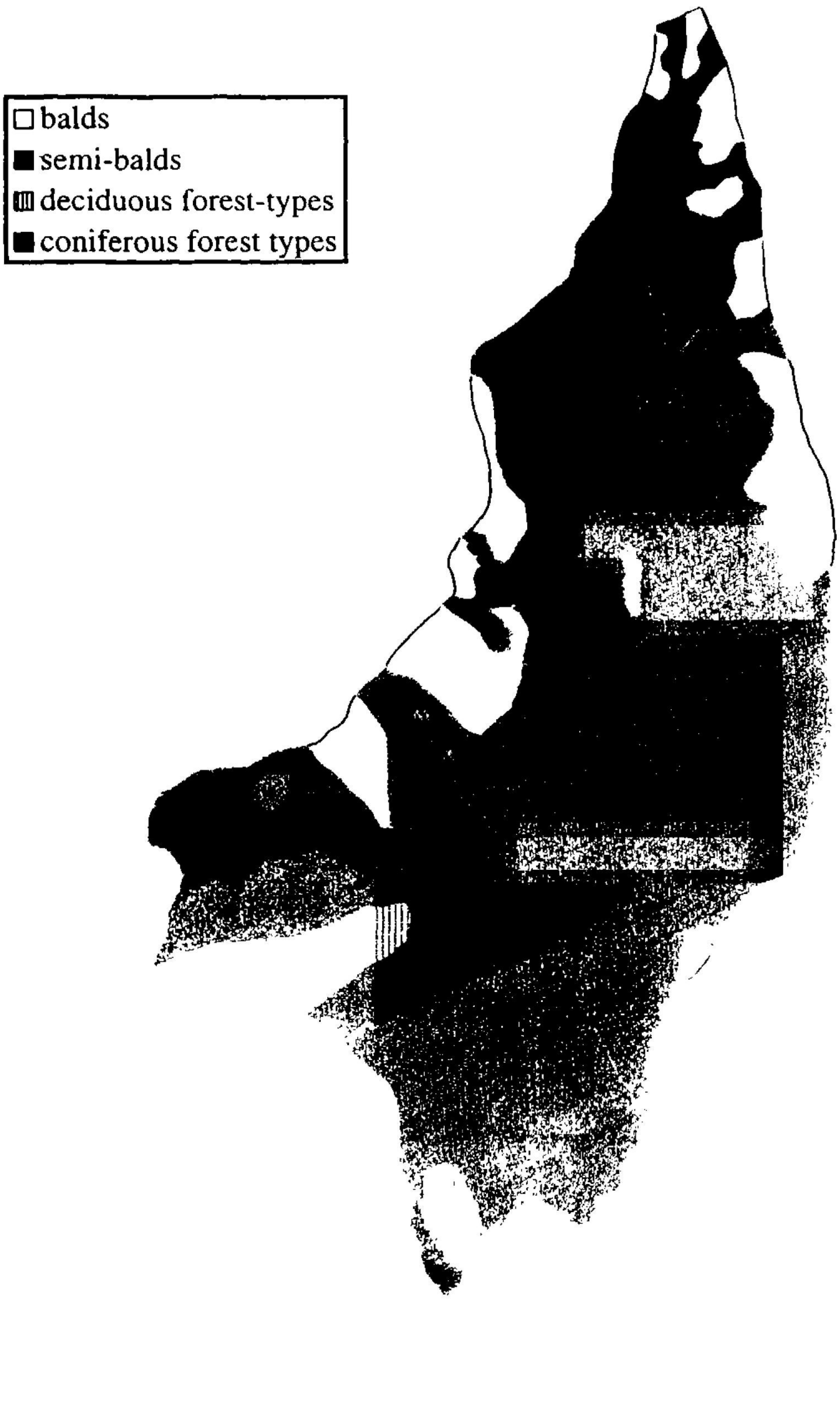

Figure 6. Vegetation types within Hadlock Brook watershed in Acadia National Park (based on aerial photographs ground-truthed with plot data).

this tree species, which is found scattered along the stream throughout the watershed. About half way up the watershed on the ridges on the eastern side is an area of *P. rigida* forest-type. These ridges are a relatively dry habitat. *Picea rubens* and *P. rubens / A. balsamea* forest-types extended from the top of the watershed (near the summit of Cadillac Mountain) to about one-third of the way down the watershed, following along both sides of the stream channel. These two forest-types generally included some interspersed deciduous trees, particularly *A. rubrum*.

The average tree height was similar in Cadillac (14 m) and Hadlock (15–16 m) watersheds (Table 4). Smaller average dbh (16.8 cm) of the trees in the deciduous forests in Cadillac reflected their post-fire establishment. The trees in Hadlock that were not exposed to the fires or other major disturbance events in the recent past had a larger average dbh in both the deciduous (26.3 cm) and coniferous forest-types (22.9 cm).

In the deciduous forest-type within Cadillac there was a higher percentage (79%) of trees that displayed no damage signs or symptoms than in either the deciduous (23%) or coniferous (53%) forest-types in Hadlock (Table 6). The mature age of the trees in Hadlock, as a result of the absence of wildfires or other major disturbance events in the recent past, may have contributed to the presence of some of the more common damage signs that were recorded. These common damage signs included cankers, broken or dead branches, open wounds, and excess resinosis or gummosis.

The understory seedling composition in the deciduous forest-type in Cadillac reflected a potential long-term species shift away from shade-intolerant species like *B. papyrifera* and *P. grandidentata* to more shade-tolerant species including *F. grandifolia* and *A. rubrum*. This speculation, however, is dependent on many factors including possible reoccurring disturbance events (e.g., rockslides, flooding, etc.) that reopen the overstory canopy and continue to favor shade-intolerant species. Insect or disease infestations (e.g., beech bark disease) are negatively affecting much of the *F. grandifolia* population in the eastern and central USA, including the trees in Acadia. (Beech bark disease is an introduced disease caused by fungi in the genus *Nectria* and spread by beech scale, *Cryptoccus fagisuga.)*

In the deciduous forest-type in Hadlock, the understory included a substantial component of *P. rubens*. This potentially could lead to a species shift of a mixed deciduous/coniferous forest-type. Again this possibility is contingent upon numerous potential biotic and abiotic influences over time.

Forest Vegetation at Acadia Compared with BBWM

The most abundant coniferous forest-types found at Acadia were similar to the only coniferous forest-types recorded at BBWM, those being *P. rubens* and *P. rubens/A. balsamea*. Differences in the most abundant deciduous forest-types were more pronounced between Acadia and BBWM. *Acer saccharum/F. grandifolia/B. alleghaniensis* and *A. rubrum*/northern hardwoods forest-types were found in all the treatment areas at BBWM. As indicated earlier, Hadlock watershed included the former forest-type. Cadillac had only *B. papyrifera* forest-type. *Acer saccharum / F. grandifolia / B. alleghaniensis* is a late successional forest-type, reflective of forests that have experienced low-intensity disturbances in which the overstory canopy is not extensively opened up. These tree species regenerate well in shaded environments, as was the case in Hadlock Brook at Acadia and BBWM (USDA Forest Service 1990). Additional details on the disturbance history of BBWM are available in Eckhoff (2000). *Betula papyrifera* is an early successional forest-type that often occurs following an extensive opening of the overstory canopy, as occurred in Cadillac Brook at Acadia in 1947. Early successional tree species require full sunlight for regeneration.

The density of live trees per hectare was lower in the two watersheds at Acadia (for the deciduous and coniferous forest-types combined) than in the manipulated and two control areas at BBWM (Table 10). However, the difference between the five areas was not statistically significant (p=0.4). The density of snags per hectare was also lower in the two watersheds at Acadia, particularly in Cadillac Brook, than in the manipulated and two control areas at BBWM. The difference between the five treatments was not statistically significant (p=0.3). The lower number of snags in Cadillac may be due to a combination of the younger forest structure (as evidenced by the smaller average dbh in Cadillac than at BBWM) and the removal of all dead or damaged trees in Cadillac following the 1947 wildfire. As a result of these activities, the number of trees that would have potentially developed into snags was reduced.

The difference between Acadia and BBWM in the more common damage signs and symptoms is reflective of the different species composition. As previously discussed, at Acadia the most common damage sign/symptom was decay, cankers, or dead branches. The decay occurred on various species. The cankers occurred most frequently on *B. alleghaniensis*. The dead branches were recorded most often on *P. rubens*. At BBWM the most common damage was cankers. The cankers occurred primarily on *F. grandifolia*, one of

Table 10. Overall comparisons between Acadia National Park (1999 data), deciduous and coniferous forest-types only, and Bear Brook Watershed in Maine (1997 data).

	Acadia National Park[1]		Bear Brook Watershed[1]		
	Cadillac	Hadlock	West Bear[2]	East Bear	A&Y
avg # live trees/ha	580	566	678	679	769
# snags/ha	60	105	113	120	108
% snags	9.4	14.6	14.3	15.0	12.3
avg live tree dbh (cm)	18	22.9	22.1	21.8	21.9
avg live crown ratio (%)	43.2	41.8	47.1	47.6	46.5
most common damage(s)	decay	cankers	cankers	cankers	cankers

[1] in deciduous and coniferous forest-type plots only at Acadia
[2] manipulated watershed

the most common tree species (constituting almost one-third of all the trees) at BBWM. Almost 100% of the *F. grandifolia* at BBWM had cankers, probably from the introduced beech bark disease. The next most common damage sign, decay, occurred primarily on *A. rubrum, A. saccharum,* and *B. alleghaniensis.*

Foliar Chemical Analyses at Acadia

The initial effects of fire and harvesting on biogeochemical cycling in forest ecosystems include elevated losses of some nutrients from the system, e.g., N (Clinton et al. 1996), Ca^{2+}, Mg^{2+}, and K^{+} (Pardo et al. 1995). The extent of the loss in relation to fires varies depending on the intensity of the fires (Vose et al. 1999). Clinton et al. (1996) and Gillon et al. (1999) found that the effects of fires on foliar N concentration levels were short-term; within two years foliage N concentrations were back to pre-fire levels in several deciduous tree species. If the effects of fire on N are short-lived as Clinton et al. (1996) and Gillon et al. (1999) propose, then impacts from the 1947 wildfire in Acadia National Park may be negligible now. Unfortunately, there are no pre- or post-fire foliar chemistry data available to compare and contrast changes with current nutrient levels.

Foliar chemical analyses from Acadia showed that N concentration for *A. rubrum* did not differ between Cadillac Brook and Hadlock Brook watersheds. N concentration for *P rubens*, on the other hand, was significantly higher in Hadlock Brook watershed than in Cadillac Brook watershed. The lower foliar N concentration in *P. rubens* in Cadillac Brook watershed might not be attributed to remaining effects of the 1947 wildfire since *P rubens* concentrations and also some nutrients concentrations such as Ca, which is also lost from the ecosystem during wildfires, could not support that conclusion. Foliar K concentrations were significantly higher in Hadlock Brook watershed in both *A. rubrum* and *P. rubens*. Foliar Ca concentrations, however, were significantly higher in Cadillac Brook watershed in both *A. rubrum* and *P. rubens*. While foliar Mn, and Zn concentrations were significantly higher in Cadillac Brook for both *A. rubrum* and *P. rubens*, foliar Cu concentration was significantly higher in Cadillac Brook only for *A. rubrum* but significantly lower for *P rubens*. The non-significant differences between watersheds for P, Mg, and B concentrations also suggest that possible effects of wildfires on foliar nutrient concentration levels in *A. rubrum* and *P. rubens* after 50 years might be insignificant.

The significantly higher foliar Al concentration in Hadlock watershed for *A. rubrum* suggests that soil Al mobility in Hadlock watershed may be higher, leading to the hypothesis that its soil might have lower pH compared to Cadillac watershed. It is also supported by the higher, although not significant, foliar Al concentration in Hadlock watershed for *P rubens*.

Foliar Chemistry at Acadia Compared with BBWM

A comparison of the foliar N and P concentration levels from Acadia with BBWM indicated that the results from both Cadillac and Hadlock watersheds were closer to the results from East Bear (the reference watershed) than West Bear (the manipulated watershed) for both *A. rubrum* and *P. rubens* (Table 9). The higher values in West Bear have been attributed to the extra N provided with the ammonium sulfate treatment (White 1996). Kahl et al. (1999) suggested that the majority of the N added by treatment on the West Bear is being retained in the watershed, reflecting biological retention in the soil and in the growing forest. Foliar N concentrations from the reference watershed, East Bear, as well as from Cadillac and Hadlock watersheds reflect ambient ecosystem levels. White (1996) indicated that, when significant differences were observed between the reference East Bear Watershed and the treated West Bear Watershed for Ca, Mg, or K in *P. rubens*, *F. grandifolia*, *A. rubrum*, and *A. saccharum*, concentrations were lower in foliage from the treated watershed. Rustad et al. (1996) indicated that the ammonium sulfate treatment has induced soil acidification with increased leaching of base cations from the soil upper horizons along with the mobile SO_4^{-2} and NO_2^- anions. The results suggest that the soil acidity induced by the treatment is being neutralized by cation exchange processes where Ca^{+2}, Mg^{+2}, and K^{+} are exchanged for H^{+} Detailed information about effects of the ammonium sulfate treatment on soil, soil-solution, and surface water can be found elsewhere (Fernandez et al. 1999; Norton et al. 1999; Wang and Fernandez 1999).

Foliar P concentrations have been found positively correlated with concentrations of N (Bernier and Brazeau 1988). Foliar N concentrations in *P. rubens* and *A. rubrum* in Hadlock watershed were positively correlated with foliar P concentration in all watersheds, with lower N and P in both watersheds at Acadia and higher N and P values in the West Bear Watershed.

Foliar Ca concentration in *A. rubrum* and *P. rubens* in Cadillac watershed was higher than in Hadlock watershed and higher than both the reference East Bear Watershed and the treated West Bear Watershed (Table 9). For K, both *A. rubrum* and *P. rubens* foliage showed lower concentrations in Acadia watersheds than in the reference East Bear Watershed, with foliar concentration from Hadlock watershed closer to the results from the reference East Bear Watershed. The foliar concentration variations in Ca and K between Cadillac and Hadlock watersheds and the reference East Bear Watershed might be attributed to soil hydrogeochemical characteristics rather than to natural disturbances occurring more than 50 years ago. Soils in Cadillac watershed might be richer in Ca but poorer in K compared with the reference watershed at the Bear Brook site.

In general, foliar Mg concentration was lower for *A. rubrum* from the Acadia watersheds than from the Bear Brook watersheds, with West Bear having the highest foliar Mg concentration. On the other hand, foliar Mg concentration was higher for *P. rubens* from the Acadia watersheds than from the Bear Brook watersheds, with West Bear having the lowest foliar Mg concentration. The discrepancy in results indicates that foliar Mg concentrations in *P. rubens* and *A. rubrum* might have not been affected by the ammonium sulfate treatment by the time of the study, 1993 (White 1996) and that foliar Mg concentrations might not be influenced by a wildfire 50 years after it occurred in Acadia National Park. Foliar Mg concentrations might be explained by chemical characteristics of the soils where those species are growing.

Foliar Al concentration from Acadia watersheds, especially Hadlock watershed, was similar to the results from the reference East Bear Watershed for *A. rubrum*. Foliar Al concentration was higher in the treated West Bear than in any of the other three watersheds. Foliar Al concentration from Acadia watersheds was lower than from both East and West Bear Watersheds for *P. rubens* (Table 9). White (1996) reported no significant differences in Al concentration for *P. rubens* between East and West Bear Watersheds. Also, foliar Al concentration between Cadillac and Hadlock watersheds was not significantly different for *P. rubens* in the present study. The significantly higher foliar Al concentration in *A. rubrum* from West Bear has been attributed to the mobility of Al in soil promoted by the ammonium sulfate treatment. The similar concentration of foliar Al between Acadia watersheds, especially Hadlock, and the reference East Bear watershed for *A. rubrum* suggests that soil Al mobility in those watersheds might also be similar. However, a soil chemical study in the Acadia watersheds is needed to compare with soil chemical analysis at the BBWM (e.g., Fernandez et al. 1999) to validate this possible explanation.

CONCLUSIONS/IMPLICATIONS

The vegetation patterns in Cadillac and Hadlock watersheds at Acadia National Park reflect a landscape mosaic. The current heterogeneity of the vegetation in the Park is attributed to several influences such as the disturbance history of the area, which included the 1947 wildfire, and the ecology of the different tree species. *Picea rubens* and *P. rubens*/*A. balsamea* forest-types cover about 70% of Hadlock watershed, with *A. saccharum, A. rubrum, F. grandifolia*, and *B. alleghaniensis* species found in the lower portion of the watershed. Cadillac watershed is covered by a more diverse deciduous and coniferous forest-types with species such as *B. papyrifera, T. occidentalis, P. rigida, P. rubens, A. balsamea*, and *A. rubrum*.

Species at the Cadillac watershed forest showed less damage signs (cankers, broken or dead branches, open wounds, and excess resinosis or gummosis) than species in Hadlock watershed. The higher damage observed in Hadlock forest is attributed to the absence of wildfires in the watershed.

The understory seedling composition in the deciduous forest-type in Cadillac might reflected a potential long-term species shift away from shade-intolerant species like *B. papyrifera* and *P. grandidentata* to more shade-tolerant species including *F. grandifolia* and *A. rubrum*. It might occur as long as shade-intolerant species are not favored by disturbance events, which might reopen the overstory canopy. Hadlock watershed's understory included a substantial component of *P. rubens*, which also suggests that in the long term a shift of a mixed deciduous/ coniferous forest-type might occur.

Forest composition was found to be different between the Bear Brook and Acadia watersheds. Tree species richness and density are higher at the BBWM than at Acadia watersheds. Common forest-types found in Acadia and Bear Brook watersheds are *P. rubens*, *P. rubens/A. balsamea*, *A. saccharum/F. grandifolia/B. alleghaniensis*, and *B. papyrifera*.

Foliar chemical analysis for *A. rubrum* and *P. rubens* between Cadillac and Hadlock watersheds showed discrepancies. Foliar N concentrations for *A. rubrum* were not different between watersheds. However, foliar N concentrations were higher for *P. rubens* from Hadlock watershed. Contrasting results between watersheds were observed for Ca, Mg, and K. These results suggest that soil nutrient availability for plant uptake might differ between watersheds as a function of soil geochemical characteristics and micro-ecological disturbances within each watershed rather than as post-effects from the 1947 wildfire. *Acer rubrum* and *P. rubens* foliar Al concentrations were higher in Hadlock watershed than in Cadillac watershed, indicating a higher soil Al mobility, which might be a result of lower soil pH in Hadlock watershed.

Foliar nutrient concentrations from the Acadia watersheds were closer to the results from the reference East Bear Watershed than from the treated West Bear Watershed. Foliar nutrient concentrations from the East Bear Brook Watershed as well as from the Acadia watersheds represent ambient characteristics. The West Bear Watershed foliar nutrient concentrations, on the other hand, represent ambient characteristics plus effects induced by the ammonium sulfate treatment.

This report provides comprehensive baseline information on forest vegetation in Cadillac and Hadlock watersheds at Acadia National Park. Data can be used to address ecological questions or to generate hypothesis regarding nutrient cycling, future forest species composition changes, or forest interactions. Foliar chemical results in this report can be strengthen or explanations presented can be challenged with soil chemical studies, which might better explain differences found between watersheds and might provide a better comparison with the long-term study at the BBWM.

Acadia National Park receives one of the highest deposition (wet and fog) rates of chemical compounds of anthropogenic origin in the eastern part of the USA. The present foliar chemistry data from Acadia National Park can be used to monitor plant responses to deposition levels in the long term.

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Table A1. Cadillac Brook watershed vegetation plot locations using a global positioning system (GPS) (Universal Transverse Mecator; NAD 1927 [Eastern USA]), also slope, aspect and terrain position information.

Plot #	---------- GPS location ------------ East	North	Slope (%)	Aspect (deg.)	Terrain Position
1	562293.9479	4910321.3013	43	114	lower slope
2	562277.5052	4910435.5072	39	330	middle slope
3	562199.1508	4910453.4934	55	314	lower hillside (steep slope)
4	562179.7477	4910474.0090	52	325	lower hillside (lots of loose rock, slide area)
5	562167.2219	4910328.8497	55	140	lower hillside (steep, rocky slope)
6	562152.4779	4910451.3038	75	310	lower hillside (on the edge of a cliff)
7	562046.7465	4910417.2310			upper hillside
8	561976.3908	4910444.2453			upper hillside
9	561953.7387	4910497.5940			NA
10	561968.1694	4910607.9907	48	340	upper hillside
11	561926.0813	4910638.3343			upper hillside
12	561893.9958	4910623.6074			upper hillside
13	561894.9441	4910497.1741			upper hillside
14	561858.0675	4910541.9447			upper hillside
15	561753.8863	4910451.2138			upper hillside
16	561717.1417	4910423.2398			upper hillside
17	561696.0235	4910392.8462			upper hillside slope
18	561677.7007	4910457.3625	9	106	upper hillside
19	561694.1104	4910584.5857			upper hillside
20	561621.0087	4910530.0272	17	332	upper hillside
21	561643.4464	4910590.4744			upper hillside
22	561672.8025	4910626.5568			upper hillside
23	561665.0676	4910586.7852			upper hillside
24	561567.8544	4910643.7632			upper hillside
25	561532.8662	4910801.1599			upper hillside (near stream)
26	561614.8159	4910715.8679			upper hillside
27	561614.1975	4910786.5330			upper hillside, near summit
28	561583.8024	4910844.7807			upper hillside, near summit
29	561625.6760	4910864.8764			upper hillside, near summit
30	561538.7127	4910965.0153	20	228	upper hillside, near summit

Table A2. Hadlock Brook watershed vegetation plot locations using a global positioning system (GPS) (Universal Transverse Mecator; NAD 1927 (Eastern USA)), also slope, aspect and terrain position information.

Plot #	GPS location East	GPS location North	Slope (%)	Aspect (deg.)	Terrain Position
1	557567.0625	4908930.50	12	140	plateau (table)
2	557834.8125	4908988.50	12	180	plateau (table)
3	557853.3750	4909002.00	49	150	upper slope
4	557812.3125	4909028.50	38	70	hillside (near a smaller summit)
5	557625.0625	4909020.50	45	56	upper hillside (near small summit)
6	557798.2500	4909063.50	26	14	lower hillside
7	557770.1250	4909141.50	37	360	midslope
8	557727.1250	4909178.50			lower hillside
9	557968.1250	4909184.50	35	36	upper hillside
10	558007.0625	4909188.50			lower hillside
11	557778.7500	4908527.00			very steep upper hillside
12	557773.4375	4908519.50			very steep upper hillside
13	557766.1250	4908574.50			upper hillside (steep slope, rocky)
14	557744.5000	4908597.00			upper hillside
15	557842.2500	4908719.50			upper hillside
16	557932.3750	4908846.00			upper hillside (creek runs through the plot)
17	557856.1875	4908849.50	84	130	upper slope
18	557971.7500	4908869.50			upper hillside
19	557978.3125	4909471.50			upper hillside (rock face within the plot)
20	557919.6875	4909508.00			lower hillside
21	557843.8750	4909464.50			lower hillside
22	557418.3750	4908770.00			upper hillside
23	557579.8750	4908826.50			lower hillside
24	557587.7500	4908759.50			lower hillside
25	557465.6250	4908894.00			upper hillside
26	557539.8750	4908886.50			upper hillside
27	557586.1250	4908873.00			upper hillside
28	557602.7500	4908896.00			summit
29	557582.3125	4908905.50			summit
30	557752.0625	4908839.50			upper hillside

Table A3. Cadillac Brook vegetation plot access and locations using distance and azimuth from nearby trails, the brook, or other landmarks.

ACCESS FROM CADILLAC BROOK AT 89 M UPSTREAM FROM MURRAY YOUNG TRAIL THE STREAM SPLITS IN TWO, THE FOLLOWING PLOT IS ON THE LEFT FORK (THE MAIN CHANNEL) (MURRY YOUNG TRAIL IS LOCATED 47 M BELOW THE BOTTOM OF THE WATERSHED BOUNDARY)

Plot 1: from the intersection of Murry Young Trail and the stream, follow the stream into the watershed 156 m then shoot an azimuth of 206 degrees azimuth and go 12 m to the plot center

ACCESS FROM CADILLAC BROOK AT 89 M UPSTREAM FROM MURRAY YOUNG TRAIL THE STREAM SPLITS IN TWO, THE FOLLOWING PLOT IS ON THE RIGHT FORK 9 (MURRY YOUNG TRAIL IS LOCATED 47 M BELOW THE BOTTOM OF THE WATERSHED BOUNDARY)

Plot 2: from the intersection of Murry Young Trail and the stream, follow the stream into the watershed 200 m then shoot an azimuth of 357 degrees and go 60 m to the plot center

Plot 3: from the intersection of Murry Young Trail and the stream, follow the stream into the watershed 200 m (same distance upstream as plot 2) then shoot an azimuth of 326 degrees and go 132 m. to the plot center

Plot 4: from the center of plot 3 shoot an azimuth of 337 degrees and go 30 m to reach the plot center

ACCESS FROM CADILLAC BROOK AT 89 M UPSTREAM FROM MURRAY YOUNG TRAIL THE STREAM SPLITS IN TWO, THE FOLLOWING PLOT IS ON THE LEFT FORK (THE MAIN CHANNEL) (MURRY YOUNG TRAIL IS LOCATED 47 M BELOW THE BOTTOM OF THE WATERSHED BOUNDARY)

Plot 5: from the intersection of Murry Young Trail and the stream, follow the stream into the watershed 312 m then shoot an azimuth of 209 degrees azimuth and go 38 m to the plot center

Plot 6: from the intersection of Murry Young Trail and the stream, follow the stream into the watershed 324 m then shoot an azimuth of 18 degrees azimuth and go 72 m to the plot center

(Plot 7 is about 130 m upstream from plot 6, however, it is located above a very steep rock cliff. Therefore, PLOTS 7 THROUGH 30 ARE BEST ACCESSED "IN REVERSE ORDER" COMING DOWN THE FIRE ROAD OR THE STREAM FROM THE TOP OF THE WATERSHED)

ACCESS FROM THE BEGINNING OF CADILLAC BROOK MEASURED AT THE WATER PUMP FOUND ALONG THE FIRE ROAD (DOWN THE FIRE ROAD FROM THE INTERSECTION OF THE CADILLAC MOUNTAIN SOUTH RIDGE TRAIL THERE IS A TRAIL HEAD MARKER AT THIS LOCATION)

Plot 7: from the beginning of the stream go 878 m downstream (120 m further along the stream from the location of plot 8 (and 9) then shoot an azimuth of 360 degrees and go 16 m to the plot center

Plot 8: from the beginning of the stream go 758 m downstream (78 m further along the stream from plot 13) this is the same location along the stream as plot 9 then shoot an azimuth of 194 degrees and go 72 m to the plot center

Plot 9: from the beginning of the stream go 758 m downstream (78 m further along the stream from plot 13) this is the same location along the stream as plot 8 then shoot an azimuth of 14 degrees and go 54 m to the plot center

Plot 10: from the center of plot 9 shoot an azimuth of 28 degrees and go 120 m to reach the plot center

Plot 11: from the center of plot 10 shoot an azimuth of 326 degrees and go 54 m to reach the plot center

Plot 12: from the center of plot 11 shoot an azimuth of 266 degrees and go 36 m to reach the plot center

Plot 13: from the beginning of the stream go 680 m downstream (158 m further along the stream from plot 15) then shoot an azimuth of 360 degrees and go 12 m to the plot center

Plot 14: from the center of plot 13 shoot an azimuth of 340 degrees and go 84 m to reach the plot center

Plot 15: from the beginning of the stream go 522 m downstream (48 m further along the stream from plot 17) then shoot an azimuth of 216 degrees and go 30 m to the plot center

Plot 16: from the center of plot 15 shoot an azimuth of 250 degrees and go 48 m to reach the plot center

Plot 17: from the beginning of the stream go 474 m downstream (48 m further along the stream from plot 18) then shoot an azimuth of 218 degrees and go 90 m to reach the plot center

Plot 18: from the beginning of the stream go 426 m downstream (24 m further along the stream from plot 19) then shoot an azimuth of 218 degrees and go 46 m to reach the plot center

Plot 19: from the beginning of the stream go 402 m downstream (66 m further along the stream from plot 20) then shoot an azimuth of 38 degrees and go 84 m to reach the plot center

Plot 20: from the beginning of the stream go 336 m downstream (30 m further along the stream from plot 21) then shoot an azimuth of 232 degrees and go 36 m to reach the plot center

Plot 21: from the beginning of the stream go 306 m downstream (94 m further along the stream from plot 24) then shoot an azimuth of 84 degrees and go 24 m to reach the plot center

Plot 22: from the center of plot 21 shoot an azimuth of 62 degrees and go 114 m to reach the plot center

Plot 23: from the center of plot 22 shoot an azimuth of 210 degrees and go 42 m to reach the plot center

Plot 24: from the beginning of the stream go 212 m downstream (170 m further along the stream from plot 25) then shoot an azimuth of 67 degrees and go 2 m to reach the plot center

Plot 25: from the beginning of the stream go 42 m downstream then shoot an azimuth of 282 degrees and go 12 m to reach the plot center

ACCESS FROM THE FIRE ROAD NEAR THE SUMMIT OF CADILLAC MOUNTAIN PLOTS LOCATED DOWNHILL OF THE INTERSECTION OF THE FIRE ROAD AND CADILLAC MOUNTAIN SOUTH RIDGE TRAIL (THERE IS A TRAIL HEAD MARKER AT THIS LOCATION), THE FOLLOWING PLOT IS LOCATED AFTER THE FIRE ROAD BECOMES NO MORE THAN A TRAIL MADE OF CARINS

Plot 26: from the intersection of the Fire Road and Cadillac Mountain South Ridge Trail go downhill on the Fire Road 210 m (84 m further along the trail from plot 27) then shoot an azimuth of 34 degrees and go 30 m to reach the plot center

ACCESS FROM THE FIRE ROAD NEAR THE SUMMIT OF CADILLAC MOUNTAIN PLOTS LOCATED DOWNHILL OF THE INTERSECTION OF THE FIRE ROAD WITH CADILLAC MOUNTAIN SOUTH RIDGE TRAIL (THERE IS A TRAIL HEAD MARKER AT THIS LOCATION)

Plot 27: from the intersection of the Fire Road and Cadillac Mountain South Ridge Trail go downhill on the Fire Road 126 m (54 m further along the trail from plot 28) then shoot an azimuth of 74 degrees and go 36 m to reach the plot center

Plot 28: from the intersection of the Fire Road and Cadillac Mountain South Ridge Trail go downhill on the Fire Road 60 m then shoot an azimuth of 76 degrees and go 30 m to reach the plot center

Plot 29: from the center of plot 28 shoot an azimuth of 86 degrees and go 48 m to reach the plot center

ACCESS FROM THE FIRE ROAD NEAR THE TOP OF CADILLAC MOUNTAIN PLOT LOCATED UPHILL OF THE INTERSECTION OF THE FIRE ROAD WITH CADILLAC MOUNTAIN SOUTH RIDGE TRAIL (THERE IS A TRAIL HEAD MARKER AT THIS LOCATION)

Plot 30: from the intersection of the Fire Road and Cadillac Mountain South Ridge Trail go uphill on the Fire Road 72 m then shoot an azimuth of 80 degrees and go 20 m to reach the plot center

Table A4. Hadlock Brook vegetation plot access and locations using distance and azimuth from nearby trails, the brook, or other landmarks.

ACCESS FROM HADLOCK TRAIL (PLOTS LOCATED ON THE SOUTH SIDE OF THE TRAIL)

Plot 1: from the intersection of the carriage road and Hadlock Trail follow the trail into the watershed 150 m then shoot an azimuth of 166 degrees and go 18 m to reach the plot center

Plot 2: from the intersection of the carriage road and Hadlock Trail follow the trail in 325 m then shoot an azimuth of 172 degrees and go 18 m to reach the plot center

Plot 3: from the center of plot 2 shoot an azimuth of 186 degrees and go 60 m to reach the plot center

ACCESS FROM HADLOCK TRAIL (PLOTS LOCATED ON THE NORTH SIDE OF THE TRAIL)

Plot 4: from the intersection of the carriage road and Hadlock Trail follow the trail in 246 m then shoot an azimuth of 347 degrees and go 108 m to reach the plot center

Plot 5: from the intersection of the carriage road and Hadlock Trail follow the trail in 318 m then shoot an azimuth of 347 degrees and go 66 m to reach the plot center

Plot 6: from the intersection of the carriage road and Hadlock Trail follow the trail in 361 m (36 m further along the trail from plot 2) then shoot an azimuth of 350 degrees and go 42 m to reach the plot center

Plot 7: from the center of plot 6 shoot an azimuth of 40 degrees and go 30 m to reach the plot center

Plot 8: from the intersection of the carriage road and Hadlock Trail follow the trail in 366 m then shoot an azimuth of 352 degrees and go 72 m to reach the plot center

Plot 9: from plot 8 shoot an azimuth of 360 degrees and go 30 m to reach the plot center

ACCESS FROM HADLOCK TRAIL (PLOTS LOCATED ON THE SOUTH SIDE OF THE TRAIL)

Plot 10: from the intersection of the carriage road and Hadlock Trail follow the trail in 457 m (96 m further along the trail from plot 6) then shoot an azimuth of 150 degrees and go 90 m to reach the plot center

Plot 11: from the intersection of the carriage road and Hadlock Trail follow the trail in 601 m (30 m further along the trail from plot 14) then shoot an azimuth of 126 degrees and go 90 m to reach the plot center

Plot 12: from the center of plot 11 shoot an azimuth of 92 degrees and go 24 m to reach the plot center

Plot 13: from the intersection of the carriage road and Hadlock Trail follow the trail in 655 m (54 m further along the trail from plot 11) then shoot an azimuth of 128 degrees and go 30 m to reach the plot center

ACCESS FROM HADLOCK TRAIL (PLOTS LOCATED ON THE NORTH SIDE OF THE TRAIL)

Plot 14: from the intersection of the carriage road and Hadlock Trail follow the trail in 571 m (210 m along the trail from plot 6) then shoot an azimuth of 308 degrees and go 138 m to reach the plot center

Plot 15: from the intersection of the carriage road and Hadlock Trail follow the trail in 697 m (126 m along the trail from plot 13) then shoot an azimuth of 308 degrees and go 18 m to reach the plot center

Plot 16: from the intersection of Hadlock Trail and Sargent Mountain Trail go southward down Hadlock Trail 306 m then shoot an azimuth of 308 degrees and go 114 m to reach the plot center

Plot 17: from the center of plot 24 shoot an azimuth of 328 degrees and go 54 m to reach the plot center

ACCESS FROM HADLOCK TRAIL (PLOTS LOCATED ON THE SOUTH SIDE OF THE TRAIL)

Plot 18: from the intersection of Hadlock Trail and Sargent Mountain Trail go southward down Hadlock Trail 174 m then shoot an azimuth of 128 degrees and go 18 m to reach the plot center

Plot 19: from the intersection of Hadlock Trail and Sargent Trail go southward down Hadlock Trail 126 m then shoot an azimuth of 148 degrees and go 60 m to reach the plot center

ACCESS FROM AMPHITHEATHER TRAIL (PLOTS LOCATED ON THE EAST SIDE OF THE TRAIL) (THE SOUTHERN BOUNDARY OF THE WATERSHED IS 129.5 M FROM THE SIGN POSTS AT THE INTERSECTION OF AMPHITHEATHER TRAIL AND SARGENT TRAIL)

Plot 20: from the intersection of Amphitheater Trail and Sargent Trail go northward up the Amphitheater Trail 201 m then shoot an azimuth of 64 degrees and go 36 m to reach the plot center

Plot 21: from the intersection of Amphitheater Trail and Sargent Trail go northward up Amphitheater Trail 189 m then shoot an azimuth of 90 degrees and go 45 m to reach the plot center (actually only 12 m inside the watershed boundary)

Plot 22: from the center of plot 21 shoot an azimuth of 350 degrees and go 54 m to reach the plot center (FYI: this plot is also located 26 m at 140 degrees from the center of plot 20)

Plot 23: from the center of plot 21 shoot an azimuth of 70 degrees and go 44 m to reach the plot center

Plot 24: from the intersection of Amphitheater Trail and Sargent Trail go northward up Sargent Trail 396 m (120 m further along the trail from plot 23) then shoot an azimuth of 306 degrees and go 48 m to reach the plot center

Plot 25: from the intersection of Amphitheater Trail and Sargent Trail go northward up Sargent Trail 552 m (156 m further along the trail from plot 24) then shoot an azimuth of 304 degrees and go 42 m to reach the plot center

Plot 26: from the center of plot 25 shoot an azimuth of 294 degrees and go 78 m to reach the plot center

Plot 27: from the intersection of Amphitheater Trail and Sargent Trail go northward up Sargent Trail 552 m (same location along the trail as plot 25) then shoot an azimuth of 24 degrees and go 40 m to reach the plot center

ACCESS FROM SARGENT MT. TRAIL (TRAIL FORMS THE BOUNDARY ON THE EAST SIDE OF THE WATERSHED)

Plot 28: from the intersection of Hadlock Trail and Sargent Mountain Trail go northward up Sargent Trail 162 m then shoot an azimuth of 257 degrees and go 48 m to reach the plot center

Plot 29: from the intersection of Hadlock Trail and Sargent Mountain Trail go northward up Sargent Trail 210 m (48 m further along the trail from plot 28) then shoot an azimuth of 256 degrees and go 84 m to reach the plot center

ACCESS FROM MAPLE SPRING TRAIL

Plot 30: from the intersection of Sargent Mountain Trail and Maple Spring Trail go west along Maple Spring Trail 228 m then shoot an azimuth of 176 degrees and go 30 m to reach the plot center

Table A5. Cadillac Brook watershed tree mensuration, crown, and damage indicator raw data from Acadia National Park in 1999.

Plot	Tree		Mensuration Indicator				Crown Indicator				Crown Width		Damage and Mortality Indicator								
#	#	Tree species	Horiz. Dist.(m)	Az. (deg)	dbh (cm)	Live/ Snag	Hgt (m)	CC[1]	% LR[2]	CV[3]	1st (m)	2nd at 90º	Loc.[4]	Type	Sev.[5]	Loc.[4]	Type	Sev.[5]	Loc.[4]	Type	Sev.[5]
1	1	*Fagus grandifolia*	4.8	82	25.9	live	15.8	cod.	80	high	7.3	5.8	4	2	0	none					
1	2	*Fraxinus americana*	6	90	30.4	live	15.2	cod.	45	mod.	4.6	5.7	1	2	0	4	2	0	none		
1	3	*Populus grandidentata*	6.3	194	13.2	live	12.7	cod.	20	low	3.3	2.7	4	1	4	7	22	3	none		
1	4	*Acer pensylvanicum*	7.2	194	17.6	live	15.8	cod.	65	high	6.5	5.8	none								
2	1	*Picea rubens*	7.3	8	21.9	live	16.0	cod.	50	high	3.8	3.6	none								
2	2	*Populus grandidentata*	4.8	20	26.7	live	19.2	cod.	45	high	4.3	3.9	none								
2	3	*Betula alleghaniensis*	3.2	32	17.3	snag															
2	4	*Betula alleghaniensis*	4.0	90	15.0	live	11.6	inter.	55	high	4.0	3.9	2	2	0	none					
2	5	*Picea rubens*	3.5	114	19.2	live	11.8	inter.	55	mod.	4.4	4.3	2	2	0	none					
2	6	*Populus grandidentata*	7.1	120	19.2	live	18.6	cod.	50	high	5.2	4.5	none								
2	7	*Betula papyrifera*	5.3	194	14.8	live	13.4	cod.	40	high	4.7	3.1	3	2	0	none					
2	8	*Betula papyrifera*	5.6	200	19.1	live	14.0	cod.	35	high	5.1	3.7	none								
2	9	*Betula papyrifera*	6.1	234	15.9	live	16.4	cod.	30	high	4.8	4.0	none								
2	10	*Betula papyrifera*	5.9	240	13.1	live	15.6	cod.	30	high	3.8	2.8	none								
2	11	*Populus grandidentata*	3.0	312	17.0	live	15.8	cod.	40	high	4.4	4.0	none								
2	12	*Populus grandidentata*	4.5	338	17.6	live	16.2	cod.	45	high	5.4	3.2	none								
2	13	*Populus grandidentata*	4.8	356	18.9	live	17.0	cod.	45	high	4.9	2.7	none								
3	1	*Betula papyrifera*	7.1	4	16.1	live	16.2	cod.	30	high	5.1	4.5	none								
3	2	*Betula papyrifera*	6.4	30	14.0	live	15.0	cod.	25	mod.	5.2	2.2	none								
3	3	*Acer pensylvanicum*	6.4	32	15.3	snag	4.5	cod.													
3	4	*Betula papyrifera*	5.3	52	15.4	live	9.54	cod.	30	high	2.5	1.2	none								
3	5	*Betula papyrifera*	3.4	76	13.5	live	14.9	cod.	25	mod.	3.5	3.3	none								
3	6	*Betula papyrifera*	5.5	78	21.1	live	16.2	cod.	40	high	6.2	3.5	none								
3	7	*Acer pensylvanicum*	6.0	108	13.1	live	8.8	cod.	50	high	7.0	4.1	none	(original main stem had broken off long ago)							
3	8	*Betula papyrifera*	3.5	204	12.9	live	13.3	cod.	25	mod.	4.1	2.9	none								
3	9	*Acer pensylvanicum*	1.4	224	14.2	live	14.7	cod.	45	high	3.8	3.6	none								
3	10	*Acer saccharum*	4.3	278	12.8	live	15.0	cod.	60	high	4.1	2.1	none								
3	11	*Betula papyrifera*	6.6	328	17.4	live	17.8	cod.	35	mod.	4.9	5.2	none								

Table A5. Continued.

Plot #	Tree #	Tree species	Mensuration Indicator Horiz. Dist.(m)	Az. (deg)	dbh (cm)	Live/ Snag	Hgt (m)	Crown Indicator CC[1]	% LR[2]	CV[3]	Crown Width 1st & 2nd at (m)	90º	Damage and Mortality Indicator Loc.[4]	Type	Sev.[5]	Loc.[4]	Type	Sev.[5]	Loc.[4]	Type	Sev.[5]
4	1	*Betula papyrifera*	1.2	30	14.3	live	14.4	cod.	35	high	4.2	3.4	none								
4	2	*Betula papyrifera*	3.1	34	14.8	live	14.8	cod.	40	high	4.0	2.3	none	(dbh measured below branch swell)							
4	3	*Betula papyrifera*	5.5	122	18.8	live	14.5	cod.	30	mod.	5.9	5.0	none								
4	4	*Acer pensylvanicum*	5.9	135	13.0	live	12.8	inter.	45	low	4.0	3.7	7	22	5	none					
4	5	*Betula papyrifera*	6.5	177	14.6	live	13.2	cod.	30	high	4.9	3.6	none								
4	6	*Acer pensylvanicum*	2.0	190	16.5	live	14.2	cod.	65	high	3.7	3.2	none								
4	7	*Acer pensylvanicum*	2.4	253	14.2	snag															
4	8	*Fraxinus americana*	6.0	310	13.0	live	10.6	cod.	35	high	4.4	4.3	none	(had a broken top at one time)							
4	9	*Acer saccharum*	6.6	312	15.7	live	8.8	cod.	55	high	6.1	5.6	none								
4	10	*Fraxinus americana*	6.0	313	16.6	live	11.4	cod.	40	high	4.9	4.1	none	(trees #8 and #10 have a common stump)							
5	1	*Betula papyrifera*	6.9	32	16.5	live	17.2	cod.	35	mod.	4.7	3.9	none								
5	2	*Betula papyrifera*	7.3	34	16.4	live	16.0	cod.	35	mod.	5.1	4.1	3	2	0	none					
5	3	*Betula papyrifera*	4.3	82	13.0	live	13.0	cod.	50	mod.	5.6	3.9	none								
5	4	*Betula papyrifera*	6.4	246	24.8	live	15.0	cod.	60	high	6.2	6.1	none								
5	5	*Betula papyrifera*	6.2	256	14.6	live	13.4	cod.	45	low	4.2	2.7	none								
5	6	*Acer rubrum*	6.9	312	12.9	live	5.2	inter.	90	low	8.1	4.6	6	21	6	none	(dbh measured above split)				
6	1	*Populus grandidentata*	0.7	164	15.3	live	9.1	cod.	30	low	4.1	2.7	none								
6	2	unknown	3.3	254	23.9	snag															
7	1	*Thuja occidentalis*	7.3	20	23.7	live															
7	2	*Thuja occidentalis*	5.0	29	25.7	live															
7	3	*Betula populifolia*	3.8	35	12.7	live															
7	4	*Thuja occidentalis*	7.1	41	16.2	live															
7	5	*Thuja occidentalis*	6.7	53	17.7	live															
7	6	*Thuja occidentalis*	7.2	55	14.7	live															
7	7	*Thuja occidentalis*	4.9	60	15.7	live															
7	8	*Thuja occidentalis*	4.8	65	20.2	live															
7	9	*Thuja occidentalis*	6.7	73	14.5	live															
7	10	*Thuja occidentalis*	2.9	80	17.9	live															
7	11	*Thuja occidentalis*	1.9	90	19.0	live															

Table A5. Continued.

Plot #	Tree #	Tree species	Mensuration Indicator Horiz. Dist.(m)	Az. (deg)	dbh (cm)	Live/ Snag	Hgt (m)	Crown Indicator CC[1]	% LR[2]	CV[3]	Crown Width 1st & 2nd at (m)	90º	Damage and Mortality Indicator Loc.[4]	Type	Sev.[5]	Loc.[4]	Type	Sev.[5]	Loc.[4]	Type	Sev.[5]
7	12	*Thuja occidentalis*	3.8	104	20.9	live															
7	13	*Thuja occidentalis*	5.4	106	18.9	live															
7	14	*Thuja occidentalis*	5.8	110	17.9	live															
7	15	*Thuja occidentalis*	4.5	123	16.4	live															
7	16	*Thuja occidentalis*	4.1	138	16.7	live															
7	17	*Thuja occidentalis*	6.7	140	14.5	live															
7	18	*Thuja occidentalis*	7.2	144	14.0	live															
7	19	*Thuja occidentalis*	5.5	150	16.4	live															
7	20	*Thuja occidentalis*	2.6	164	25.9	live															
7	21	*Thuja occidentalis*	6.7	184	25.5	live															
7	22	*Thuja occidentalis*	6.4	192	24.1	live															
7	23	*Thuja occidentalis*	5.9	204	27.6	live															
7	24	*Thuja occidentalis*	6.6	240	13.4	live															
7	25	*Thuja occidentalis*	6.4	243	20.2	live															
7	26	*Thuja occidentalis*	6.6	265	25.4	live															
7	27	*Thuja occidentalis*	7.0	268	14.6	live															
7	28	*Thuja occidentalis*	3.5	282	15.0	live															
7	29	*Thuja occidentalis*	5.9	285	16.0	live															
7	30	*Thuja occidentalis*	2.4	303	20.7	live															
7	31	*Thuja occidentalis*	1.9	350	14.1	snag															
8		no trees																			
9	1	*Thuja occidentalis*	6.8	82	17.6	live															
10	1	*Pinus rigida*	1.8	4	30.0	live	3.8	cod.	90	high	5.6	4.5	none								
10	2	*Pinus rigida*	5.1	186	23.1	live	3.8	cod.	40	low	3.8	2.0	1	3	4	7	22	5	none		
10	3	*Pinus rigida*	3.3	228	18.5	live	3.6	cod.	75	high	4.7	3.2	none(dbh measured above branch swell)								
10	4	*Pinus rigida*	5.4	244	26.2	live	5.6	cod.	80	high	5.2	4.9	none								
10	5	*Pinus rigida*	7.3	283	24.3	live	2.6	cod.	45	high	4.8	4.0	none	(trees #5 and 6 are same base but forked below dbh)							

Table A5. Continued.

Plot #	Tree #	Tree species	Mensuration Indicator: Horiz. Dist.(m)	Az. (deg)	dbh (cm)	Live/ Snag	Hgt (m)	Crown Indicator: CC[1]	% LR[2]	CV[3]	Crown Width: 1st (m)	& 2nd at 90º	Damage and Mortality Indicator: Loc.[4]	Type	Sev.[5]	Loc.[4]	Type	Sev.[5]	Loc.[4]	Type	Sev.[5]
10	6	*Pinus rigida*	7.3	285	23.0	live	5.6	cod.	35	high	3.8	3.7	3	3	4	none					
11		no trees																			
12		no trees																			
13	1	*Picea rubens*	3.3	162	16.6	live															
13	2	*Acer rubrum*	4.9	238	13.5	live	(forked at 4 ft, dbh measured at 4.5 ft)														
13	3	*Picea rubens*	4.0	241	14.8	live															
13	4	*Picea rubens*	6.5	292	18.7	live															
13	5	*Abies balsamea*	4.6	300	12.9	live															
13	6	*Picea rubens*	6.2	354	16.1	live															
13	7	*Betula papyrifera*	5.0	358	13.5	live															
14		no trees																			
15	1	*Thuja occidentalis*	4.5	40	21.4	live															
15	2	*Abies balsamea*	7.1	190	13.9	live															
16	1	*Quercus rubra*	6.9	284	24.5	live															
17	1	*Abies balsamea*	1.3	169	15.1	live	(dbh measured below swell and branch)														
17	2	*Thuja occidentalis*	7.1	182	17.9	live															
17	3	*Abies balsamea*	3.3	340	12.7	live															
18	1	*Thuja occidentalis*	6.6	12	13.7	live	4.4	cod.	75	high	2.6	2.3	none								
18	2	*Thuja occidentalis*	7.2	38	12.7	live	3.4	cod.	95	high	2.9	2.7	none								
18	3	*Thuja occidentalis*	4.3	156	12.9	live	4.0	cod.	95	high	3.1	2.9	none								
18	4	*Thuja occidentalis*	3.7	180	12.7	live	4.0	cod.	95	high	2.4	2.2	none								
18	5	*Picea rubens*	5.6	193	23.6	live	7.4	open	100	high	4.5	4.4	6	21	0	none					
18	6	*Picea rubens*	6.5	335	17.0	live	5.0	cod.	95	mod.	4.7	2.4	7	22	2	none					
18	7	*Thuja occidentalis*	4.1	358	17.4	live	4.8	cod.	75	high	3.5	3.4	none	(dbh measured below wound where a branch is attached)							
19	1	*Abies balsamea*	3.0	196	27.8	live															
20	1	*Picea rubens*	5.2	152	14.0	live															

Table A5. Continued.

Plot #	Tree #	Tree species	Mensuration Indicator Horiz. Dist.(m)	Az. (deg)	dbh (cm)	Live/ Snag	Hgt (m)	Crown Indicator CC[1]	% LR[2]	CV[3]	Crown Width 1st & 2nd at (m)	90º	Damage and Mortality Indicator Loc.[4]	Type	Sev.[5]	Loc.[4]	Type	Sev.[5]	Loc.[4]	Type	Sev.[5]
21	1	*Picea rubens*	5.0	330	19.0	live															
22		no trees																			
23	1	*Abies balsamea*	5.3	250	20.3	live															
24	1	*Picea rubens*	6.9	40	23.3	snag															
24	2	*Picea rubens*	2.7	62	13.6	live															
24	3	*Picea rubens*	6.3	62	15.8	live															
24	4	*Picea rubens*	5.3	94	13.7	live															
24	5	*Acer rubrum*	6.4	124	17.3	live															
24	6	*Acer rubrum*	6.4	130	22.2	live	(tree split to ground dbh taken on the live half only at 4.5 ft)														
24	7	*Picea rubens*	1.8	214	31.0	live															
24	8	*Picea rubens*	3.7	262	33.9	live															
24	9	*Picea rubens*	6.6	264	32.4	snag															
25	1	*Abies balsamea*	1.7	69	17.6	live															
25	2	*Abies balsamea*	4.9	81	13.9	live															
25	3	*Betula alleghaniensis*	1.7	107	15.0	live															
25	4	*Abies balsamea*	7.2	107	17.5	live															
25	5	*Abies balsamea*	4.4	114	13.3	live															
25	6	*Abies balsamea*	2.0	141	19.5	live															
25	7	*Abies balsamea*	5.6	195	16.2	live	(severly broken off top)														
25	8	*Abies balsamea*	2.7	240	14.5	live															
25	9	*Abies balsamea*	6.0	247	14.9	live															
25	10	*Abies balsamea*	5.5	249	13.9	snag															
25	11	unknown	3.7	273	15.6	snag															
25	12	*Abies balsamea*	4.5	289	15.3	live															
25	13	*Betula alleghaniensis*	5.6	289	17.5	snag															
25	14	*Abies balsamea*	5.3	300	12.9	live															
25	15	*Betula alleghaniensis*	6.5	302	14.1	live															
25	16	*Abies balsamea*	5.8	314	23.6	live															
25	17	*Abies balsamea*	2.3	354	15.3	live															

Table A5. Continued.

Plot	Tree		Mensuration Indicator					Crown Indicator			Crown Width		Damage and Mortality Indicator								
			Horiz.	Az.	dbh	Live/	Hgt		%		1st & 2nd at										
#	#	Tree species	Dist.(m)	(deg)	(cm)	Snag	(m)	CC[1]	LR[2]	CV[3]	(m)	90º	Loc.[4]	Type	Sev.[5]	Loc.[4]	Type	Sev.[5]	Loc.[4]	Type	Sev.[5]
25	18	*Abies balsamea*	5.1	360	15.9	live															
26	1	*Abies balsamea*	6.0	90	14.5	live															
27	no trees																				
28	1	*Picea rubens*	6.6	148	19.2	snag															
29	no trees																				
30	1	*Picea rubens*	5.9	22	18.4	live	9.0	cod.	30	mod.	2.9	2.7	none								
30	2	*Picea rubens*	3.6	56	24.6	live	11.0	cod.	75	high	4.8	4.6	none								
30	3	*Picea rubens*	0.7	88	25.5	live	11.0	cod.	60	high	4.0	3.8	none								
30	4	*Picea rubens*	6.4	120	22.2	live	9.5	cod.	50	low	3.5	2.9	6	21	0	7	22	5	none		
30	5	*Picea rubens*	2.3	160	20.8	live	13.1	cod.	80	high	4.0	3.2	none								
30	6	*Picea rubens*	4.7	268	13.1	live	6.4	inter.	70	high	3.1	3.0	none								
30	7	*Picea rubens*	3.1	282	13.0	live	2.8	inter.	40	mod.	2.6	2.3	none								
30	8	*Picea rubens*	3.7	294	24.7	live	12.4	cod.	70	high	3.9	2.5	none								
30	9	*Picea rubens*	6.0	308	24.4	snag															
30	10	*Betula alleghaniensis*	2.8	322	14.0	snag															
30	11	*Picea rubens*	5.3	338	31.8	live	12.3	cod.	80	high	7.4	5.1	none								

[1]Crown class
[2]Live ratio
[3]Crown vigor
[4]Location
[5]Severity

Table A6. Hadlock Brook watershed tree mensuration, crown, and damage indicator raw data from Acadia National Park in 1999.

Plot #	Tree #	Tree species	Mensuration Indicator Horiz. Dist.(m)	Az. (deg)	dbh (cm)	Live/ Snag	Hgt (m)	Crown Indicator CC[1]	% LR[2]	CV[3]	Crown Width 1st (m)	2nd at 90º	Damage and Mortality Indicator Loc.[4]	Type	Sev.[5]	Loc.[4]	Type	Sev.[5]	Loc.[4]	Type	Sev.[5]
1	1	unknown	6.5	38	29.5	snag	2.7														
1	2	*Betula alleghaniensis*	2.4	136	53.7	live	19.5	dom.	40	high	18.3	13.0	3	2	0	none					
1	3	*Fagus grandifolia*	5.4	166	19.8	live	12.0	cod.	70	high	8.2	8.0	1	3	4	3	1	8	1	8	
1	4	*Fagus grandifolia*	7.2	194	14.7	live	11.9	cod.	70	high	8.0	7.0	3	1	5	none					
1	5	unknown	5.0	276	62.5	snag	8.2														
1	6	*Picea rubens*	4.2	332	31.7	live	17.2	cod.	70	mod.	8.3	8.1	none								
2	1	*Betula alleghaniensis*	3.9	70	28.7	live	15.6	cod.	50	high	10.9	8.6	4	1	4	6	21	3	none		
2	2	*Betula alleghaniensis*	7.3	80	32.1	live	17.4	cod.	30	mod.	7.1	6.8	7	22	2	none					
2	3	*Acer saccharum*	6.2	152	37.2	live	18.6	dom.	20	mod.	12.9	9.8	7	22	2	none					
2	4	unknown	3.9	158	16.7	snag															
2	5	*Acer saccharum*	6.8	168	24.1	live	15.8	cod.	35	mod.	4.5	3.5	3	2	0	none					
2	6	*Acer rubrum*	6.2	172	17.5	live		cod.	25	poor	5.0	3.5	none								
2	7	*Picea rubens*	3.2	186	19.7	snag															
2	8	*Betula alleghaniensis*	4.0	208	25.0	live	14.3	cod.	45	mod.	6.5	5.4	none								
2	9	*Betula alleghaniensis*	5.0	248	15.5	live	12.2	cod.	35	mod.	7.4	5.1	4	1	3	none					
2	10	*Fagus grandifolia*	6.2	256	14.8	live	7.8	co d.	30	poor	7.2	6.4	4	1	8	6	21	4	none		
2	11	*Picea rubens*	7.0	310	26.7	live	17.4	cod.	75	mod.	5.1	4.6	6	4	4	none					
3	1	*Betula alleghaniensis*	5.2	0	23.8	live	18.6	cod.	25	mod.	6.8	5.6	4	1	3	none					
3	2	*Picea rubens*	5.9	38	15.7	live	8.8	inter.	45	mod.	5.0	4.2	7	22	3	none					
3	3	*Betula alleghaniensis*	7.1	50	13.0	live	13.7	inter.	40	mod.	6.4	5.1	3	1	2	none					
3	4	*Picea rubens*	6.2	81	23.9	live	19.8	cod.	35	mod.	5.7	4.1	none								
3	5	*Picea rubens*	5.9	108	28.1	live	16.1	cod.	25	mod.	6.3	5.8	5	4	2	none					
3	6	*Betula alleghaniensis*	3.6	141	16.6	snag	4.6														
3	7	*Betula alleghaniensis*	6.9	120	13.0	snag	6.0														
3	8	*Picea rubens*	6.6	157	23.5	live	17.9	cod.	25	mod.	4.3	5.0	3	1	4	none					
3	9	*Picea rubens*	4.9	169	16.0	live	15.8	cod.	35	mod.	3.1	3.0	none								
3	10	*Betula alleghaniensis*	2.1	184	16.1	live	13.2	cod.	20	low	3.7	2.6	4	1	2	none					
3	11	*Betula alleghaniensis*	6.5	192	12.7	snag	11.4														

Table A6. Continued.

Plot #	Tree #	Tree species	Mensuration Indicator Horiz. Dist.(m)	Az. (deg)	dbh (cm)	Live/ Snag	Hgt (m)	Crown Indicator CC[1]	% LR[2]	CV[3]	Crown Width 1st (m)	2nd at 90º	Damage and Mortality Indicator Loc.[4]	Type	Sev.[5]	Loc.[4]	Type	Sev.[5]	Loc.[4]	Type	Sev.[5]
3	12	*Picea rubens*	3.5	198	28.0	live	20.9	cod.	70	mod.	6.8	4.5	none								
3	13	*Picea rubens*	4.9	228	13.2	live	13.8	inter.	35	low	4.1	3.6	none								
3	14	*Picea rubens*	5.3	232	19.8	live	12.3	cod.	55	mod.	5.4	3.2	7	22	6	none					
3	15	*Picea rubens*	4.3	270	15.3	live	16.0	inter.	50	mod.	2.9	2.8	7	22	2	none					
3	16	*Betula alleghaniensis*	4.6	284	19.0	live	13.3	cod.	20	low	5.0	2.2	4	2	0	7	22	3	none		
3	17	*Picea rubens*	5.5	304	15.7	live	16.7	inter.	40	mod.	4.1	3.8	7	22	2	none					
3	18	*Betula alleghaniensis*	4.3	314	16.3	live	16.3	cod.	20	mod.	3.5	3.3	1	1	3	7	22	2	none		
3	19	*Picea rubens*	6.1	350	16.0	live	12.5	inter.	20	low	3.3	3.2	3	4	3	7	22	7	none		
4	1	*Picea rubens*	5.9	204	16.8	live	12.0	cod.	80	mod.	5.0	4.5	7	22	3	none					
4	2	*Picea rubens*	6.3	222	20.0	live	16.1	dom.	80	low	3.0	4.5	7	22	7	none					
4	3	*Picea rubens*	6.5	300	18.7	live	11.3	open.	100	high	6.3	6.1	7	22	3	none					
5	1	*Picea rubens*	5.8	212	14.5	live	7.1	inter.	70	high	4.0	4.7	7	22	3	none					
6	1	*Picea rubens*	3.6	0	19.0	live	15.6	cod.	35	mod.	3.9	2.9	none								
6	2	*Picea rubens*	6.4	0	23.9	live	17.4	cod.	20	mod.	3.6	3.6	none								
6	3	*Picea rubens*	1.5	24	42.2	live	22.0	cod.	50	mod.	6.3	6.2	7	22	2	none					
6	4	*Picea rubens*	6.7	26	21.2	live	19.2	cod.	20	mod.	4.1	3.9	none								
6	5	*Picea rubens*	3.5	82	24.9	live	17.2	cod.	15	low	3.2	2.8	7	22	2	3	4	3	none		
6	6	*Picea rubens*	4.8	112	24.0	live	16.8	cod.	50	mod.	4.4	4.1	7	22	2	none					
6	7	*Picea rubens*	5.7	120	15.0	live	12.4	inter.	25	low	2.6	2.2	none								
6	8	*Picea rubens*	4.7	130	29.8	live	15.8	cod.	10	low	6.0	5.2	7	22	9	6	21	3	none		
6	9	*Picea rubens*	6.1	151	29.0	live	13.0	inter.	80	low	6.2	4.3	7	22	6	6	21	0	none		
6	10	*Picea rubens*	6.8	181	13.3	live	12.0	inter.	40	mod.	3.3	3.2	none								
6	11	*Betula alleghaniensis*	3.7	190	15.2	live	14.8	cod.	10	low	3.7	3.3	4	1	7	none					
6	12	*Picea rubens*	6.5	231	27.5	live	16.0	cod.	55	mod.	6.1	5.3	7	22	2	none					
6	13	*Picea rubens*	7.0	251	35.1	live	21.0	dom.	40	high	7.4	6.8	none								
6	14	*Picea rubens*	1.9	258	29.5	live	20.0	dom.	50	mod.	4.8	3.5	none								
6	15	*Picea rubens*	3.4	283	19.4	live	15.0	cod.	40	high	3.6	3.2	none								
6	16	*Picea rubens*	4.8	286	21.2	live	19.6	cod.	25	mod.	2.3	2.1	3	3	2	none					
6	17	*Picea rubens*	6.3	326	20.8	live	18.4	cod.	30	mod.	3.2	1.7	none								
6	18	*Picea rubens*	5.0	334	15.7	live	16.8	cod.	20	low	2.8	2.3	none								

Table A6. Continued.

			Mensuration Indicator					Crown Indicator			Crown Width		Damage and Mortality Indicator								
Plot #	Tree #	Tree species	Horiz. Dist.(m)	Az. (deg)	dbh (cm)	Live/ Snag	Hgt (m)	CC[1]	% LR[2]	CV[3]	1st & 2nd at (m)	90º	Loc.[4]	Type	Sev.[5]	Loc.[4]	Type	Sev.[5]	Loc.[4]	Type	Sev.[5]
6	19	*Picea rubens*	6.9	344	18.0	live	15.6	cod.	25	mod.	3.2	2.6	none								
7	1	*Betula alleghaniensis*	6.6	8	16.6	live	13.4	cod.	20	mod.	2.5	1.9	3	2	0	5	2		none		
7	2	*Betula alleghaniensis*	5.4	16	13.1	live	10.7	inter.	85	high	4.7	4.2	3	1	3	none					
7	3	*Picea rubens*	7.0	48	30.9	live	18.4	cod.	45	high	6.0	3.9	none								
7	4	*Picea rubens*	2.5	96	32.3	live	19.6	cod.	50	high	4.0	3.4	none								
7	5	*Betula alleghaniensis*	3.5	132	20.6	live	15.0	cod.	60	high	7.0	6.0	3	1	6	none					
7	6	*Acer pensylvanicum*	6.4	132	14.5	snag															
7	7	*Picea rubens*	4.7	174	42.5	live	24.9	dom.	60	high	7.1	6.4	none								
7	8	*Picea rubens*	3.6	190	14.6	live	12.8	inter.	30	high	4.9	2.0	none								
7	9	*Betula alleghaniensis*	2.7	202	19.6	snag															
7	10	unknown	5.2	208	29.5	snag															
7	11	*Picea rubens*	6.9	218	22.5	live	17.8	cod.	50	high	4.7	3.6	none								
7	12	*Picea rubens*	6.4	252	43.7	live	21.0	cod.	35	high	6.5	6.4	none								
7	13	*Picea rubens*	2.4	262	31.7	live	16.1	cod.	40	high	4.5	3.4	none								
7	14	*Picea rubens*	6.8	268	19.5	snag															
7	15	*Picea rubens*	4.3	280	29.5	live	21.2	cod.	40	high	4.3	3.5	none								
7	16	unknown	4.3	296	15.5	snag															
7	17	*Picea rubens*	7.2	304	18.2	live	14.8	inter.	25	mod.	4.2	3.8	none								
7	18	*Picea rubens*	3.3	306	16.1	snag															
7	19	unknown	4.1	320	21.6	snag															
7	20	*Picea rubens*	5.1	322	14.7	live	15.2	inter.	25	mod.	2.8	1.9	none								
7	21	*Picea rubens*	2.5	328	19.3	live	15.2	inter.	35	high	5.1	3.9	none								
7	22	*Betula alleghaniensis*	7.2	336	21.9	snag															
7	23	*Picea rubens*	5.5	340	16.6	live	13.0	inter.	20	mod.	3.4	3.1	none								
7	24	*Picea rubens*	6.2	346	14.2	snag															
7	25	*Picea rubens*	5.0	352	30.7	live	19.0	cod.	40	high	6.0	4.0	none								
8	1	*Picea rubens*	2.2	88	13.1	live															
8	2	*Picea rubens*	5.0	88	41.8	live															
8	3	*Betula alleghaniensis*	4.0	90	16.5	snag															
8	4	*Acer rubrum*	7.1	98	27.9	live															

Table A6. Continued.

			Mensuration Indicator					Crown Indicator			Crown Width		Damage and Mortality Indicator								
Plot #	Tree #	Tree species	Horiz. Dist.(m)	Az. (deg)	dbh (cm)	Live/ Snag	Hgt (m)	CC[1]	% LR[2]	CV[3]	1st (m)	2nd at 90º	Loc.[4]	Type	Sev.[5]	Loc.[4]	Type	Sev.[5]	Loc.[4]	Type	Sev.[5]
8	5	*Picea rubens*	5.5	218	43.7	live															
9	1	*Picea rubens*	2.3	146	49.0	live	20.0	dom.	80	high	10.4	9.8	7	22	3	none					
9	2	*Picea rubens*	4.7	180	27.4	live	18.7	cod.	50	mod.	6.2	5.3	none								
9	3	*Picea rubens*	6.9	208	14.0	snag															
9	4	*Picea rubens*	7.0	212	25.2	live	17.5	cod.	70	mod.	6.5	5.6	none								
9	5	*Picea rubens*	6.5	348	20.3	live	11.2	cod.	90	high	4.9	4.6	none								
10	1	*Picea rubens*	4.1	18	16.8	live															
10	2	*Picea rubens*	7.3	22	23.1	live															
10	3	*Acer rubrum*	4.9	40	24.4	live															
10	4	*Acer rubrum*	3.7	42	16.8	live															
10	5	*Picea rubens*	6.5	66	34.0	live															
10	6	*Acer rubrum*	7.1	102	17.8	live															
10	7	*Picea rubens*	2.7	166	19.8	live															
10	8	*Picea rubens*	3.6	169	19.0	live															
10	9	*Picea rubens*	2	186	30.1	live															
10	10	*Picea rubens*	5.6	200	30.8	live															
10	11	*Picea rubens*	6.9	222	16.2	live															
10	12	*Picea rubens*	6.8	236	28.3	live															
10	13	*Picea rubens*	5.6	258	15.8	live															
10	14	*Betula alleghaniensis*	6.4	260	13.0	live															
10	15	*Picea rubens*	0.6	278	32.1	live															
10	16	*Betula alleghaniensis*	7.1	330	21.1	live															
10	17	*Picea rubens*	7.0	344	22.8	live															
11	1	*Picea rubens*	1.3	18	13.3	live															
11	2	*Picea rubens*	4.2	28	21.5	live															
11	3	*Picea rubens*	6.5	78	13.4	live															
11	4	*Picea rubens*	7.0	100	30.7	live															
11	5	*Picea rubens*	3.3	142	13.8	live															
11	6	*Picea rubens*	5.9	334	22.1	live															
11	7	*Picea rubens*	4.2	346	21.8	live															

Table A6. Continued.

Plot #	Tree #	Tree species	Mensuration Indicator: Horiz. Dist.(m)	Az. (deg)	dbh (cm)	Live/ Snag	Hgt (m)	Crown Indicator: CC[1]	% LR[2]	CV[3]	Crown Width: 1st & 2nd (m)	at 90º	Damage and Mortality Indicator: Loc.[4]	Type	Sev.[5]	Loc.[4]	Type	Sev.[5]	Loc.[4]	Type	Sev.[5]
12	1	*Picea rubens*	3.5	28	30.2	live															
12	2	*Picea rubens*	5.7	96	14.1	live															
12	3	*Picea rubens*	6.4	178	29.6	snag															
12	4	*Picea rubens*	5.3	200	31.5	live															
12	5	*Picea rubens*	6.6	226	31.3	live															
12	6	*Picea rubens*	1.2	227	19.7	snag															
12	7	*Picea rubens*	4.8	264	14.6	live															
12	8	*Picea rubens*	7	272	19.8	live															
12	9	*Picea rubens*	5.3	312	19.2	live															
12	10	*Picea rubens*	5.5	342	25.3	live															
13	1	*Picea rubens*	3.2	2	18.1	live															
13	2	*Picea rubens*	1.0	6	13.4	live															
13	3	*Picea rubens*	6.1	26	13.5	live															
13	4	*Picea rubens*	5.1	34	19.2	live															
13	5	*Betula alleghaniensis*	6.8	63	14.2	snag															
13	6	*Betula alleghaniensis*	6.8	65	15.3	live															
13	7	*Picea rubens*	7.0	85	17.3	live															
13	8	*Betula alleghaniensis*	5.5	98	20.2	live															
13	9	*Picea rubens*	2.4	114	19.8	live															
13	10	*Betula alleghaniensis*	5.2	148	23.5	snag															
13	11	*Picea rubens*	1.5	162	23.3	live															
13	12	*Picea rubens*	7.1	174	15.5	live															
13	13	*Picea rubens*	6.9	214	13.5	live															
13	14	*Abies balsamea*	3.7	224	20.7	live															
13	15	*Picea rubens*	5.7	250	16.6	live															
13	16	*Picea rubens*	2.2	340	17.4	live															
13	17	*Picea rubens*	3.7	340	14.6	live															
13	18	*Picea rubens*	7.3	355	20.4	live															
14	1	*Acer rubrum*	7.3	24	23.0	live	(trees #1 and 2 have a common base)														
14	2	*Acer rubrum*	7.3	24	13.1	live	(trees #1 and 2 have a common base)														

Table A6. Continued.

Plot #	Tree #	Tree species	Mensuration Indicator Horiz. Dist.(m)	Az. (deg)	dbh (cm)	Live/ Snag	Crown Indicator Hgt (m)	CC[1]	% LR[2]	CV[3]	Crown Width 1st & 2nd (m)	at 90º	Damage and Mortality Indicator Loc.[4]	Type	Sev.[5]	Loc.[4]	Type	Sev.[5]	Loc.[4]	Type	Sev.[5]
14	3	*Acer rubrum*	6.6	30	18.2	live	(dbh measured below wound)														
14	4	*Picea rubens*	3.5	39	43.6	live															
14	5	*Picea rubens*	7.0	240	16.9	live															
14	6	*Picea rubens*	3.1	314	27.5	live															
14	7	*Picea rubens*	3.6	316	31.9	live															
14	8	*Picea rubens*	3.1	346	31.4	live															
14	9	*Betula alleghaniensis*	6.2	352	13.3	live															
15	1	*Picea rubens*	6.2	38	23.0	live															
15	2	*Picea rubens*	4.8	107	23.2	live	(forked above dbh one side dead)														
15	3	*Picea rubens*	5.2	136	31.3	live															
15	4	*Picea rubens*	4.2	156	21.5	live															
15	5	*Picea rubens*	3.4	175	28.1	live															
15	6	*Picea rubens*	5.3	180	15.4	live	(forked above dbh dbh measured above, one side was only 12.6cm)														
15	7	*Picea rubens*	5.6	186	20.1	live															
15	8	*Picea rubens*	6.1	190	18.2	live															
15	9	*Picea rubens*	3.3	262	15.6	live	(distance to tree measured level over the rocks not down to the tree base)														
15	10	*Picea rubens*	4.5	270	27.3	live	(distance to tree measured level over the rocks not down to the tree base)														
15	11	*Picea rubens*	5.2	282	20.9	live	(distance to tree measured level over the rocks not down to the tree base)														
15	12	*Picea rubens*	4.3	300	28.8	live	(distance to tree measured level over the rocks not down to the tree base)														
15	13	*Picea rubens*	6.1	358	36.6	live															
16	1	*Betula alleghaniensis*	6.5	2	27.1	live															
16	2	*Picea rubens*	1.3	72	24.5	live															
16	3	*Betula alleghaniensis*	6.1	98	19.0	snag															
16	4	*Betula alleghaniensis*	6.1	124	27.3	live															
16	5	*Betula alleghaniensis*	7.1	144	16.3	live	(only one live epicormic branch, otherwise dead tree)														
16	6	*Picea rubens*	2.6	150	13.6	live															
16	7	*Picea rubens*	1.6	152	17.6	snag															
16	8	*Picea rubens*	4.0	188	20.7	live															
16	9	*Picea rubens*	3.7	192	35.0	live															
16	10	*Picea rubens*	2.6	224	18.8	live															

Table A6. Continued.

Plot #	Tree #	Tree species	Mensuration Indicator Horiz. Dist.(m)	Az. (deg)	dbh (cm)	Live/ Snag	Hgt (m)	Crown Indicator CC[1]	% LR[2]	CV[3]	Crown Width 1st & 2nd (m)	at 90º	Damage and Mortality Indicator Loc.[4]	Type	Sev.[5]	Loc.	Type	Sev.	Loc.	Type	Sev.
16	11	*Betula alleghaniensis*	5.8	230	17.1	live															
16	12	*Acer rubrum*	1.7	238	42.5	live															
16	13	*Betula alleghaniensis*	5.0	242	20.5	live															
16	14	*Picea rubens*	4.6	290	15.4	live															
16	15	*Picea rubens*	5.6	298	42.0	snag															
16	16	*Abies balsamea*	6.0	346	15.8	live															
17	1	*Picea rubens*	5.3	78	18.7	live	7.8	cod.	85	high	6.0	4.5	7	22	2	none					
17	2	*Betula alleghaniensis*	6.1	134	18.9	live	7.8	cod.	55	high	6.0	5.4	5	3	3	none					
17	3	*white pine*	7.0	233	17.3	live	4.4	open.	80	mod.	4.3	3.8	6	21	4	none					
18	1	*Picea rubens*	6.0	2	15.3	live															
18	2	*Picea rubens*	7.0	78	31.4	live															
18	3	*Picea rubens*	4.4	185	14.3	live															
18	4	*Picea rubens*	2.2	200	21.4	live															
18	5	*Picea rubens*	2.6	260	16.7	live															
18	6	*Picea rubens*	5.7	274	14.1	live															
18	7	*Picea rubens*	3.5	300	16.2	live															
18	8	*Picea rubens*	1.0	324	19.5	live															
19	1	*Abies balsamea*	2.9	15	17.1	live															
19	2	*Picea rubens*	4.9	28	18.2	live															
19	3	*Picea rubens*	6.3	33	16.4	live															
19	4	*Picea rubens*	4.1	125	36.8	live															
19	5	*Picea rubens*	7.1	238	25.4	live															
19	6	*Betula alleghaniensis*	5.1	260	25.4	snag															
19	7	*Betula alleghaniensis*	5.4	268	20.4	snag															
19	8	*Picea rubens*	5.1	286	22.9	live															
19	9	*Picea rubens*	4.6	328	13.2	snag															
19	10	conifer	6.9	331	20.9	snag															
19	11	*Abies balsamea*	6.3	342	21.9	live															
19	12	*Picea rubens*	3.4	348	16.7	live															
20	1	*Betula alleghaniensis*	4.4	180	23.3	live															

Table A6. Continued.

Plot #	Tree #	Tree species	Mensuration Indicator Horiz. Dist.(m)	Az. (deg)	dbh (cm)	Live/ Snag	Hgt (m)	Crown Indicator CC[1]	% LR[2]	CV[3]	Crown Width 1st & 2nd at (m)	90°	Damage and Mortality Indicator Loc.[4]	Type	Sev.[5]	Loc.	Type	Sev.	Loc.	Type	Sev.
20	2	*Betula alleghaniensis*	5.4	244	24.8	live	(dbh measured below wounds at 3.5 ft)														
20	3	*Picea rubens*	4.8	284	18.1	live															
20	4	*Betula sp.*	6.3	288	14.4	snag	(severely decayed)														
21	1	*Picea rubens*	5.6	52	40.3	live															
21	2	*Betula alleghaniensis*	1.4	66	20.6	snag	(dbh measured above split in bark at about 5½ ft above ground)														
21	3	*Picea rubens*	5.6	125	50.5	live															
21	4	*Betula alleghaniensis*	7.3	258	14.2	live															
21	5	*Picea rubens*	5.5	268	44.1	live															
21	6	*Betula alleghaniensis*	5.5	282	17.8	snag															
21	7	*Picea rubens*	2.5	354	25.6	live															
22	1	*Picea rubens*	6.0	270	17.2	live															
23	1	*Picea rubens*	6.5	120	21.4	live															
23	2	*Picea rubens*	4.9	164	24.5	live															
23	3	*Picea rubens*	6.9	172	13.4	live															
23	4	*Picea rubens*	6.3	180	28.0	live															
23	5	*Picea rubens*	5.4	282	28.7	live															
23	6	*Picea rubens*	4.6	286	14.7	snag															
23	7	*Picea rubens*	6.6	296	16.1	live															
23	8	*Picea rubens*	5.0	304	13.9	live															
23	9	*Picea rubens*	1.7	314	23.5	live															
23	10	*Picea rubens*	1.7	330	23.2	live	(trees #10 and 11 forked at dbh)														
23	11	*Picea rubens*	1.7	334	19.3	live	(trees #10 and 11 forked at dbh)														
23	12	*Picea rubens*	6.7	342	28.0	snag															
23	13	*Picea rubens*	1.9	346	21.1	live															
23	14	*Larix laricina*	5.2	350	20.8	live															
24	1	*Picea rubens*	4.8	14	16.6	live															
24	2	*Picea rubens*	6.5	78	25.5	live															
24	3	*Picea rubens*	6.7	116	31.7	live															
24	4	*Picea rubens*	2.1	144	20.7	live															
24	5	*Picea rubens*	4.5	146	37.7	live															

Table A6. Continued.

			Mensuration Indicator					Crown Indicator			Crown Width		Damage and Mortality Indicator								
Plot #	Tree #	Tree species	Horiz. Dist.(m)	Az. (deg)	dbh (cm)	Live/ Snag	Hgt (m)	CC[1]	% LR[2]	CV[3]	1st & 2nd (m)	at 90º	Loc.[4]	Type	Sev.[5]	Loc.	Type	Sev.	Loc.	Type	Sev.
24	6	*Picea rubens*	5.5	150	15.7	live															
24	7	*Picea rubens*	2.4	288	26.7	live															
25		no trees																			
26	1	*Picea rubens*	1.7	14	16.0	live															
26	2	unknown	6.9	74	19.6	snag															
26	3	*Picea rubens*	7.0	96	24.7	live															
26	4	*Picea rubens*	3.6	120	25.1	live															
26	5	*Picea rubens*	4.1	142	49.0	live															
26	6	*Picea rubens*	5.2	200	35.5	live															
26	7	*Picea rubens*	5.6	228	20.8	live															
26	8	*Picea rubens*	4.7	250	26.7	live															
26	9	*Picea rubens*	2.0	257	37.8	live															
26	10	*Picea rubens*	6.6	296	30.6	live															
26	11	*Betula alleghaniensis*	3.7	318	15.2	snag															
26	12	*Picea rubens*	5.4	334	18.7	live															
26	13	*Picea rubens*	5.7	336	22.5	live															
26	14	*Picea rubens*	1.5	353	12,8	snag															
27	1	*Picea rubens*	4.5	12	13.6	live															
28		no trees																			
29		no trees																			
30	1	*Thuja occidentalis*	3.7	108	32.2	live															
30	2	*Thuja occidentalis*	3.6	112	25.2	live															
30	3	*Picea rubens*	5.8	262	22.7	live															
30	4	*Picea rubens*	6.0	310	15.8	live															
30	5	*Abies balsamea*	5.1	316	19.8	live															

[1]Crown class [2]Live ratio [3]Crown vigor [4]Location [5]Severity

Table A7. Cadillac Brook and Hadlock Brook watersheds: Site tree mensuration, crown, and damage indicator raw data from Acadia National Park in 1999.

			Mensuration Indicator					Crown Indicator			Crown Width		Damage and Mortality Indicator								
Water-#	Tree #	Tree species	Horiz. Dist.(m)	Az. (deg)	dbh (cm)	Live/ Snag	Hgt (m)	CC[1]	% LR[2]	CV[3]	1st & (m)	2nd at 90º	Loc.[4]	Type	Sev.[5]	Loc.	Type	Sev.	Loc.	Type	Sev.
Cadillac	1	*Acer saccharum*	9.3	65	19.9	Live	15.2	cod.	70	high	7.4	7.3	None								
Cadillac	2	*Populus grandidentata*	10.0	51	19.6	Live	18.0	cod.	30	high	5.8	5.8	None								
Cadillac	3	*Betula papyrifera*	10.6	50	15.1	Live	16.1	cod.	50	high	3.5	3.0	3	2	0	None					
Cadillac	4	*Betula papyrifera*	14.6	224	14.4	Live	12.8	cod.	35	high	3.6	3.2	None								
Cadillac	5	*Betula papyrifera*	9.7	162	21.3	Live	15.8	cod.	50	high	9.4	7.3	None								
Cadillac	6	*Betula papyrifera*	14.7	188	14.0	Live	14.6	cod.	40	high	5.3	4.8	None								
Cadillac	10	*Pinus rigida*	18.0	344	25.1	Live	5.2	cod.	65	high	5.0	3.0	None	(dbh taken below branch swell)							
Cadillac	18	*Thuja occidentalis*	8.2	143	15.7	Live	3.6	cod.	95	high	2.4	2.2	4	3	2	6	3	3	None*		
Cadillac	30	*Picea rubens*	8.2	98	23.3	Live	11.5	cod.	65	high	5.4	2.9	None								
Hadlock	1	*Betula alleghaniensis*	11.2	220	25.2	Live	18.4	cod.	25	mod.	5.7	5.4	None								
Hadlock	2	*Betula alleghaniensis*	8.1	91	28.7	Live	18.0	cod.	80	high	8.6	7.5	None								
Hadlock	3	*Picea rubens*	9.3	238	30.1	Live	17.2	cod.	75	high	5.2	5.0	None								
Hadlock	4	*Pinus strobus*	13.2	114	36.1	Live	15.8	cod.	40	mod.	10.2	6.7	6	21	3	None					
Hadlock	5	*Picea rubens*	18.6	242	48.6	Live	20.2	cod.	95	high	9.5	8.0	7	22	2	None					
Hadlock	6	*Picea rubens*	21.7	6	35.7	Live	22.4	cod.	50	high	5.6	4.1	None								
Hadlock	7	*Picea rubens*	13.7	180	28.7	Live	20.4	cod.	55	high	5.6	3.5	None								
Hadlock	9	*Picea rubens*	8.3	91	33.9	Live	18.7	dom.	70	high	7.3	6.5	None	(this tree is larger than most)							
Hadlock	17	*Picea rubens*	13.6	68	18.8	Live	9.9	cod	55	mod.	3.7	04	None								

[1]Crown class [2]Live ratio [3]Crown vigor [4]Location [5]Severity

* in Cadillac Brook plot 18 the dbh was taken below the swell; and the tree is forked and one side has stripped bark but it is still alive

Table A8. Cadillac Brook watershed sapling mensuration, crown, and damage indicator raw data from Acadia National Park in 1999.

			Mensuration Indicator				Crown Indicator			Damage and Mortality Indicator								
Plot #	Tree #	Sapling Species	Horizon. Dist.(m)	Az. (deg)	dbh (cm)	Height (m)	CC[1]	% LR[2]	CV[3]	Loc.[4] Sap	Type	Sev.[5]	Loc. Tree	Type	Sev.	Loc. Tree	Type	Sev.
1	1	*Fagus grandifolia*	1.1	51	2.8	3.9	over.	33	mod.	3	1	5	none					
1	2	*Fraxinus americana*	1.5	70	10.7	13.5	inter.	25	mod.	none								
1	3	*Acer pensylvanicum*	1.9	172	3.1	6.5	over.	70	high	none								
1	4	*Acer pensylvanicum*	1.7	232	4.3	8.2	inter.	50	high	none								
2	1	*Acer pensylvanicum*	1.3	24	5.1	7.8	inter.	60	high	none								
2	2	*Acer pensylvanicum*	1.9	152	2.8	5.0	over.	55	high	none								
2	3	Acer pensylvanicum	1.5	300	3.9	6.2	over.	50	high	none								
2	4	*Acer pensylvanicum*	1.7	320	2.7	4.1	over.	40	high	none								
3	1	*Acer pensylvanicum*	1.4	0	4.2	4.3	inter.	50	high	none								
3	2	*Acer pensylvanicum*	1.5	84	4.4	4.6	inter.	75	mod.	7	22	3	none					
3	3	*Acer pensylvanicum*	1.0	268	3.9	5.2	inter.	70	mod	none								
4	1	*Betula papyrifera*	1.2	122	10.2	12.4	cod.	20	low	2	3	4	none					
4	2	*Acer pensylvanicum*	1.7	148	4.6	6.8	inter.	75	high	none								
5	1	*Betula papyrifera*	1.3	16	8.7	3.8	over.	50	high	none								
5	2	*Acer pensylvanicum*	0.3	347	2.4	3.6	over.	70	high	none								
6	1	*Betula papyrifera*	1.9	272	8.9	8.7	cod.	90	high	none								
6	2	*Betula papyrifera*	2.0	280	6.0	7.4	inter.	45	low	7	22	4	none					
10		no saplings																
18		no saplings																
30	1	*Abies balsamea*	1.7	130	6.2	3.5	over	80	mod.	7	22	3	none					

[1]Crown class [2]Live ratio [3]Crown vigor [4]Location [5]Severity

Table A9. Hadlock Brook watershed sapling mensuration, crown, and damage indicator raw data from Acadia National Park in 1999.

Plot #	Tree #	Sapling Species	Mensuration Indicator: Horizon. Dist.(m)	Az. (deg)	dbh (cm)	Height (m)	Crown Indicator: CC[1]	% LR[2]	CV[3]	Damage and Mortality Indicator: Loc.[4] Sap	Type	Sev.[5]	Loc. Tree	Type	Sev.	Loc. Tree	Type	Sev.
1	1	*Fagus grandifolia*	1.1	86	11.8	7.7	inter.	60	mod.	1	1	7	3	1	9	5	1	9
2	1	*Picea rubens*	1.2	30	3.2	3.5	over.	45	mod.	7	22	3	none					
3	1	*Amelanchier* sp.	1.6	9	2.7	4	over.	20	low	7	22	4	none					
4	1	*Picea rubens*	1.4	158	12.3	6.3	open.	50	mod.	7	22	2	none	(dbh measured above old lost leader)				
5	1	*Pinus strobus*	0.7	200	11.5	5.9	open.	70	mod.	7	22	3	none					
6	no saplings																	
7	1	*Betula alleghaniensis*	0.5	50	7.0	1.9	over.	40	high	none	(forked: one side is rotten the other side is healthy)							
7	2	*Betula alleghaniensis*	2.0	60	9.0	3.6	over.	50	mod.	5	2	0	none					
7	3	*Picea rubens*	1.6	180	9.4	3.2	over.	85	high	none								
9		no saplings																
17	1	*Picea rubens*	1.0	70	10.8	6.8	cod.	50	high	none								
17	2	*Picea rubens*	1.2	118	11.8	5.5	cod.	70	high	7	22	2	none					
17	3	*Picea rubens*	1.0	218	2.8	3.1	over.	80	high	none								

[1]Crown class [2]Live ratio [3]Crown vigor [4]Location [5]Severity

Table A10. Cadillac Brook watershed seedling mensuration and crown indicator raw data from Acadia National Park, 1999.

Plot No.	Seedling No.	Seedling Species	Crown Class	Crown Exposure to Sunlight	Crown Vigor	Height (meters)
1	1	*Fagus grandifolia*	overtopped	limited	low	3.2
1	2	*Fagus grandifolia*	overtopped	limited	high	3.8
1	3	*Fagus grandifolia*	overtopped	limited	low	1.0
1	4	*Acer pensylvanicum*	overtopped	limited	moderate	2.2
1	5	*Acer pensylvanicum*	overtopped	limited	high	3.7
1	6	*Acer pensylvanicum*	overtopped	limited	high	3.9
1	7	*Abies balsamea*	overtopped	limited	moderate	1.6
1	8	*Acer pensylvanicum*	overtopped	limited	high	3.0
2	1	*Acer pensylvanicum*	overtopped	poor	low	3.5
2	2	*Acer pensylvanicum*	overtopped	poor	low	4.2
2	3	*Acer pensylvanicum*	overtopped	moderate	high	4.7
2	4	*Acer pensylvanicum*	overtopped	moderate	moderate	3.4
2	5	*Acer pensylvanicum*	overtopped	poor	moderate	1.7
2	6	*Acer pensylvanicum*	overtopped	poor	high	1.1
3	1	*Acer pensylvanicum*	overtopped	high	moderate	0.9
3	2	*Acer pensylvanicum*	overtopped	high	low	0.5
4	1	*Acer pensylvanicum*	overtopped	moderate	high	1.1
4	2	*Acer pensylvanicum*	overtopped	moderate	high	1.5
4	3	*Acer pensylvanicum*	overtopped	moderate	high	0.7
4	4	*Acer pensylvanicum*	overtopped	moderate	high	1.3
4	5	*Acer pensylvanicum*	overtopped	moderate	high	1.1
4	6	*Acer pensylvanicum*	overtopped	moderate	high	0.7
4	7	*Acer pensylvanicum*	overtopped	moderate	high	2.8
4	8	*Acer pensylvanicum*	overtopped	moderate	high	2.1
5	1	*Acer rubrum*	overtopped	moderate	high	0.5
6	1	*Acer pensylvanicum*	overtopped	moderate	moderate	1.7
6	2	*Acer pensylvanicum*	overtopped	moderate	moderate	0.7
1		no seedlings				
18	1	*Picea rubens*	open grown	high	high	0.9
18	2	*Betula sp.*	overtopped	moderate	moderate	1.4
30	1	*Abies balsamea*	overtopped	moderate	high	0.7

Table A11. Hadlock Brook watershed seedling mensuration and crown indicator raw data from Acadia National Park, 1999.

Plot No.	Seedling No.	Seedling Species	Crown Class	Crown Exposure to Sunlight	Crown Vigor	Height (meters)
1	1	*Picea rubens*	overtopped	limited	moderate	0.9
1	2	*Picea rubens*	overtopped	limited	moderate	0.8
1	3	*Fagus grandifolia*	overtopped	limited	high	1.6
1	4	*Picea rubens*	overtopped	limited	moderate	0.6
1	5	*Picea rubens*	overtopped	high	moderate	1.7
1	6	*Picea rubens*	overtopped	high	high	0.8
1	7	*Picea rubens*	overtopped	limited	moderate	0.5
1	8	*Picea rubens*	overtopped	high	moderate	1.0
1	9	*Picea rubens*	overtopped	limited	high	0.5
1	10	*Fagus grandifolia*	overtopped	limited	high	0.7
1	11	*Fagus grandifolia*	overtopped	limited	high	0.7
1	12	*Fagus grandifolia*	overtopped	poor	high	0.4
1	13	*Fagus grandifolia*	overtopped	limited	moderate	1.1
2	1	*Picea rubens*	overtopped	poor	moderate	0.5
2	2	*Acer pensylvanicum*	overtopped	moderate	moderate	2.2
2	3	*Picea rubens*	overtopped	poor	moderate	0.7
2	4	*Acer pensylvanicum*	overtopped	moderate	moderate	1.3
2	5	*Acer pensylvanicum*	overtopped	poor	moderate	0.4
2	6	*Acer pensylvanicum*	overtopped	poor	poor	0.8
2	7	*Acer pensylvanicum*	overtopped	poor	poor	0.8
2	8	*Picea rubens*	overtopped	poor	poor	0.9
2	9	*Acer pensylvanicum*	overtopped	poor	poor	0.4
2	10	*Picea rubens*	overtopped	moderate	poor	1.0
2	11	*Acer pensylvanicum*	overtopped	high	high	3.2
2	12	*Picea rubens*	overtopped	poor	poor	1.4
2	13	*Acer pensylvanicum*	overtopped	moderate	high	2.0
2	14	*Acer pensylvanicum*	overtopped	poor	moderate	0.8
2	15	*Acer pensylvanicum*	overtopped	poor	moderate	0.4
2	16	*Acer pensylvanicum*	overtopped	moderate	high	2.1
2	17	*Abies balsamea*	overtopped	moderate	high	1.8
2	18	*Picea rubens*	overtopped	moderate	moderate	1.6
2	19	*Picea rubens*	overtopped	poor	moderate	0.8
2	20	*Acer pensylvanicum*	overtopped	poor	poor	0.6
2	21	*Picea rubens*	overtopped	poor	moderate	1.2
2	22	*Picea rubens*	overtopped	poor	moderate	1.2
2	23	*Picea rubens*	overtopped	poor	poor	0.4
2	24	*Picea rubens*	overtopped	poor	poor	1.1
2	25	*Picea rubens*	overtopped	poor	moderate	1.7
2	26	*Picea rubens*	overtopped	poor	poor	1.2
2	27	*Picea rubens*	overtopped	poor	moderate	2.0
2	28	*Picea rubens*	overtopped	moderate	poor	1.8
2	29	*Picea rubens*	overtopped	poor	poor	1.2
2	30	*Picea rubens*	overtopped	poor	poor	0.8

Table A11. Continued.

Plot No.	Seedling No.	Seedling Species	Crown Class	Crown Exposure to Sunlight	Crown Vigor	Height (meters)
2	31	*Picea rubens*	overtopped	poor	poor	1.4
3	1	*Picea rubens*	overtopped	high	moderate	2.2
3	2	*Picea rubens*	overtopped	moderate	low	1.4
4	1	*Amelanchier sp.*	overtopped	high	low	1.2
5	1	*Acer pensylvanicum*	overtopped	limited	moderate	1.1
5	2	*Acer pensylvanicum*	overtopped	limited	moderate	0.9
5	3	*Acer pensylvanicum*	overtopped	limited	moderate	1.0
5	4	*Acer pensylvanicum*	overtopped	limited	moderate	0.6
6	1	*Acer pensylvanicum*	overtopped	moderate	moderate	0.5
6	2	*Acer pensylvanicum*	overtopped	moderate	high	0.5
6	3	*Acer pensylvanicum*	overtopped	moderate	moderate	1.0
6	4	*Pinus strobus*	overtopped	moderate	high	0.5
7	1	*Betula alleghaniensis*	overtopped	moderate	low	0.5
9	1	*Picea rubens*	overtopped	moderate	high	0.6
9	2	*Picea rubens*	overtopped	moderate	high	0.5
9	3	*Picea rubens*	overtopped	moderate	moderate	0.7
9	4	*Betula alleghaniensis*	overtopped	moderate	moderate	0.3
9	5	*Picea rubens*	overtopped	moderate	high	0.4
9	6	*Picea rubens*	overtopped	moderate	low	0.4
9	7	*Acer pensylvanicum*	overtopped	moderate	high	0.4
9	8	*Picea rubens*	overtopped	moderate	high	0.5
9	9	*Picea rubens*	overtopped	moderate	high	0.5
9	10	*Picea rubens*	overtopped	moderate	high	0.4
9	11	*Picea rubens*	overtopped	moderate	moderate	0.3
9	12	*Picea rubens*	overtopped	moderate	high	0.5
9	13	*Picea rubens*	overtopped	moderate	high	0.7
9	14	*Picea rubens*	overtopped	moderate	high	0.5
9	15	*Picea rubens*	overtopped	moderate	low	0.4
9	16	*Picea rubens*	overtopped	moderate	low	0.7
9	17	*Picea rubens*	overtopped	moderate	moderate	0.3
9	18	*Picea rubens*	overtopped	moderate	low	0.3
9	19	*Picea rubens*	overtopped	moderate	high	0.5
17	1	*Abies balsamea*	overtopped	limited	moderate	1.1
17	2	*Abies balsamea*	overtopped	limited	low	0.7

Table A12. Locations of the foliar chemistry samples for *Acer rubrum* from Cadillac Brook and Hadlock Brook watersheds in Acadia National Park, 1999.

Sample	Closest plot	Reference location	Comments
a) Cadillac Brook watershed: *Acer rubrum* samples			
1	plot 24	N of plot	
2	plot 24	E of plot	
3	plot 24	S of plot	
4	plot 24	further S of plot	
5	plot 21	N of plot	
6	plot 21	W of plot	
7	plot 21	W of plot	
8	plot 21	S of plot	or maybe east of plot 15; steep terrain
9	plot 15	W of sample 8	close to both plots 13 and 15
10	plot 15	S of sample 9	close by to sample 9; small stream close
11	between plots 15 & 14	E of sample 10	steep hillside
12	between plots 15 & 14	E of sample 11	just a little ways E
13	between plots 15 & 14	N of sample 12	steep hillside; leaving plot 15 it gets dense
14	between plots 15 & 14	E of sample 13	seept rocky, loose boulders, dense veg. area
15	plot 14	W of plot	also E of sample 14
16	plot 14	E of plot	
17	plot 14	S of plot	between plots 13 and 14
18	plot 13	S/SW of plot	
19	plot 13	W of plot	near creek
20	plot 13	E of plot	
b) Hadlock Brook watershed: *Acer rubrum* samples			
1	on way to plot 10	E of trail intersection	
2	heading towards plot 10	E of sample 1	
3	plot 10	W of plot	also E of plots 1 and 2
4	plot 10	SE of plot	
5	plot 10	N/NE of plot	
6	plot 10	E of plot sw of plot 26	
7	plot 26	S of plot	no red maples in sight for long distance N
8	plot 26	E of plot	E heads towards plot 25 and a bald
9	plot 26	further S from plot	headed to plot 24
10	plot 24	N of plot	long ways S of plot 26
11	plot 24	E of plot	
12	plot 24	W of plot	
13	plot 24	S of plot	
14	plot 6	W/SW of plot	

Table A12. Continued.

Sample	Closest plot	Reference location	Comments
15	plot 7	S of plot	collected leaves off the tree standing on cliff
16	plot 7	W of plot	
17	plot 9	S of plot	same as W of plot 8 so close together
18	plot 9	N of plot	
19	plot 9	E of plot	
20	plot 9	quite a way E of plot	

Table A13. Locations of the foliar chemistry samples for *Picea rubens* from Cadillac Brook and Hadlock Brook watersheds in Acadia National Park, 1999.

Sample	Closest plot	Reference location	Comments
a) Cadillac Brook watershed: *Picea rubens* samples			
1	plot 24	N of plot	
2	plot 24	E of plot	
3	plot 24	S of plot	
4	plot 24	W of plot	
5	plot 24	further S of plot	also N of 21; between plots 24 & 21
6	plot 21	N of plot	
7	plot 21	W of plot	
8	plot 21	S of plot	
9	plot 21	E of plot	
10	plot 21	SW of plot	W of sample 8; across the stream
11	plot 21	further S of plot	also E of plot 20
12	plot 18	N of plot	S of sample 10
13	plot 14	W of plot	
14	plot 14	W of plot	E of sample 13
15	plot 14	W of plot	at the plot
16	plot 14	S of plot	at the plot
17	plot 13	S of plot	near creek
18	plot 13	N of plot	
19	plot 13	W of plot	
20	plot 13	E of plot	
b) Hadlock Brook watershed: *Picea rubens* samples			
1	on way to plot 10	E of trail intersection	
2	towards plot 10	E of sample 1	
3	plot 10	W of plot	can see blue flagging to the plot center
4	plot 10	S of plot	long way to reach one with low enough boughs
5	plot 10	N of plot	
6	plot 10	E of plot	
7	plot 26	S of plot	
8	plot 26	W of plot	
9	plot 26	N of plot	
10	plot 24	N of plot	
11	plot 24	E of plot	
12	plot 24	W of plot	
13	plot 24	S of plot	
14	plot 7	N of plot	
15	plot 7	S of plot	also S of plot 6
16	plot 7	E of plot	
17	plot 9	S of plot	
18	plot 9	N of plot	
19	plot 9	E/NE of plot	
20	plot 9	W of plot	

Table A14. *Acer rubrum* foliar chemistry analyses from Cadillac Brook watershed and Hadlock Brook watershed in Acadia National Park in 1999 (all nutrients mg/kg except Cd which is :g/kg and N which is %).

Tree Species	Water-shed Name	Sample #	N %	Ca mg/kg	K mg/kg	Mg mg/kg	P mg/kg	Al mg/kg	B mg/kg	Cu mg/kg	Mn mg/kg
Acer rubrum	Cadillac	1	2.19	5683	8768	1591	1126	18.9	34.0	8.13	423
Acer rubrum	Cadillac	2	1.87	5981	6382	1310	1058	5.27	40.6	9.40	349
Acer rubrum	Cadillac	3	2.24	4790	10210	918	1282	3.95	68.0	8.44	406
Acer rubrum	Cadillac	4	2.25	6729	8201	1054	1224	7.33	54.9	8.23	365
Acer rubrum	Cadillac	5	2.09	3285	4559	969	1063	7.71	42.0	12.60	182
Acer rubrum	Cadillac	6	1.84	14780	5425	1239	953	11.7	33.9	8.15	462
Acer rubrum	Cadillac	7	1.82	6104	6311	1322	910	15.7	15.4	5.44	562
Acer rubrum	Cadillac	8	1.54	3441	7227	732	881	4.69	22.1	5.53	206
Acer rubrum	Cadillac	9	1.33	3141	7603	606	799	5.80	27.7	5.90	150
Acer rubrum	Cadillac	10	1.46	9631	6028	876	762	15.2	31.3	8.40	441
Acer rubrum	Cadillac	11	1.56	4416	5627	696	800	16.3	23.4	4.08	337
Acer rubrum	Cadillac	12	1.86	5288	6775	1052	1030	7.08	29.1	9.14	233
Acer rubrum	Cadillac	13	1.51	5047	6025	1075	771	1.54	28.4	8.10	341
Acer rubrum	Cadillac	14	1.69	5839	4745	1226	997	8.18	25.0	5.70	351
Acer rubrum	Cadillac	15	1.59	5456	5912	1104	697	3.21	31.3	5.24	292
Acer rubrum	Cadillac	16	1.64	7287	6329	1081	779	9.09	52.5	3.36	321
Acer rubrum	Cadillac	17	1.86	12832	4900	1749	982	7.67	36.5	3.51	530
Acer rubrum	Cadillac	18	1.48	7763	5168	1236	871	2.74	20.9	5.63	414
Acer rubrum	Cadillac	19	1.70	6162	6614	1120	878	4.37	47.5	10.6	552
Acer rubrum	Cadillac	20	1.51	6539	4738	997	894	5.46	25.5	10.4	338

Table A14. Continued.

Tree Species	Watershed Name	Sample #	N %	Ca mg/kg	K mg/kg	Mg mg/kg	P mg/kg	Al mg/kg	B mg/kg	Cu mg/kg	Mn mg/kg
Acer rubrum	Hadlock	1	1.93	6697	7186	1123	792	16.1	42.9	4.76	302
Acer rubrum	Hadlock	2	1.92	4235	13853	1163	886	10.3	50.2	5.03	477
Acer rubrum	Hadlock	3	2.03	4933	8818	418	861	13.1	53.1	6.51	499
Acer rubrum	Hadlock	4	1.95	3311	9384	810	1027	7.25	45.2	11.1	135
Acer rubrum	Hadlock	5	1.88	4693	10090	1200	909	7.92	77.5	6.03	507
Acer rubrum	Hadlock	6	2.10	9237	4599	2408	1150	16.5	33.2	5.54	98.6
Acer rubrum	Hadlock	7	1.71	3032	6229	1056	1010	7.86	20.4	4.15	71.7
Acer rubrum	Hadlock	8	1.77	2830	8048	1192	734	10.2	15.9	3.62	48.7
Acer rubrum	Hadlock	9	2.03	3079	6343	1349	813	10.3	43.2	4.99	68.2
Acer rubrum	Hadlock	10	1.99	6287	6619	1162	698	7.13	19.9	3.39	68.7
Acer rubrum	Hadlock	11	1.95	3546	7168	1384	1025	10.3	19.6	3.02	55.8
Acer rubrum	Hadlock	12	1.82	4013	7835	923	731	7.39	9.7	3.45	67.2
Acer rubrum	Hadlock	13	1.64	4140	5189	1871	873	8.61	20.2	5.92	56.5
Acer rubrum	Hadlock	14	2.03	3046	8049	644	885	3.28	25.9	9.26	50.1
Acer rubrum	Hadlock	15	1.66	3047	7325	538	833	7.06	21.5	4.44	42.3
Acer rubrum	Hadlock	16	1.49	4835	5833	813	647	27.9	14.9	5.93	50.7
Acer rubrum	Hadlock	17	1.46	4038	3660	1419	950	17.0	13.8	1.78	63.6
Acer rubrum	Hadlock	18	1.55	3855	4384	1137	658	5.90	12.9	3.20	71.3
Acer rubrum	Hadlock	19	1.54	5034	5055	1061	626	8.08	15.9	2.61	81.6
Acer rubrum	Hadlock	20	1.53	5753	5566	1095	722	14.2	15.3	3.37	78.6

Table A14. Continued.

Tree Species	Water-shed Name	Sample #	Fe mg/kg	Zn mg/kg	Cd µg/kg	Pb mg/kg
Acer rubrum	Cadillac	1	52.3	36.4	83.1	0.31
Acer rubrum	Cadillac	2	67.2	56.0	77.4	<0.23
Acer rubrum	Cadillac	3	52.0	40.3	56.4	<0.23
Acer rubrum	Cadillac	4	45.4	43.5	122.0	0.52
Acer rubrum	Cadillac	5	38.1	25.8	48.0	<0.23
Acer rubrum	Cadillac	6	170.0	50.0	134.0	<0.23
Acer rubrum	Cadillac	7	41.4	34.4	92.3	<0.23
Acer rubrum	Cadillac	8	31.9	17.1	28.0	<0.23
Acer rubrum	Cadillac	9	37.1	18.5	49.1	0.51
Acer rubrum	Cadillac	10	35.3	26.0	127.0	0.38
Acer rubrum	Cadillac	11	46.2	28.6	55.3	0.23
Acer rubrum	Cadillac	12	52.2	33.6	104.0	<0.23
Acer rubrum	Cadillac	13	38.9	26.3	73.6	<0.23
Acer rubrum	Cadillac	14	43.0	22.8	91.8	<0.23
Acer rubrum	Cadillac	15	37.0	32.1	85.1	0.38
Acer rubrum	Cadillac	16	47.7	45.8	114.0	<0.23
Acer rubrum	Cadillac	17	36.4	48.0	363.0	<0.23
Acer rubrum	Cadillac	18	36.6	40.0	181.0	0.55
Acer rubrum	Cadillac	19	53.3	49.8	96.1	<0.23
Acer rubrum	Cadillac	20	40.4	80.9	130.0	<0.23
Acer rubrum	Hadlock	1	51.4	42.3	68.7	<0.23
Acer rubrum	Hadlock	2	48.7	28.4	43.1	0.52
Acer rubrum	Hadlock	3	44.8	21.6	48.2	0.25
Acer rubrum	Hadlock	4	45.2	29.9	26.3	0.33
Acer rubrum	Hadlock	5	61.9	29.3	83.3	<0.23
Acer rubrum	Hadlock	6	35.2	39.7	170.0	0.35
Acer rubrum	Hadlock	7	52.0	25.1	57.0	0.30
Acer rubrum	Hadlock	8	55.0	26.3	49.2	<0.23
Acer rubrum	Hadlock	9	67.6	30.2	74.9	0.25
Acer rubrum	Hadlock	10	31.2	24.2	41.6	0.25
Acer rubrum	Hadlock	11	43.1	21.4	28.3	<0.23
Acer rubrum	Hadlock	12	35.3	21.2	46.9	0.48
Acer rubrum	Hadlock	13	32.0	28.8	74.5	<0.23
Acer rubrum	Hadlock	14	50.2	43.1	71.5	0.33
Acer rubrum	Hadlock	15	94.6	25.4	71.5	0.29
Acer rubrum	Hadlock	16	37.1	25.0	45.7	0.42
Acer rubrum	Hadlock	17	34.3	16.9	89.7	1.12
Acer rubrum	Hadlock	18	36.4	14.0	71.0	0.25
Acer rubrum	Hadlock	19	87.6	35.2	132.0	0.24
Acer rubrum	Hadlock	20	39.9	21.3	119.0	0.34

Table A15. *Picea rubens* foliar chemistry analyses from Cadillac Brook watershed and Hadlock Brook watershed in Acadia National Park in 1999 (all nutrients mg/kg except N which is % and Cd which is µg/kg).

Tree Species	Water-shed Name	Sample #	N %	Ca mg/kg	K mg/kg	Mg mg/kg	P mg/kg	Al mg/kg	B mg/kg	Cu mg/kg	Mn mg/kg
Picea rubens	Cadillac	1	1.19	1492	6799	858	963	34.1	14.7	2.84	196
Picea rubens	Cadillac	2	1.01	1354	5405	1065	751	28.6	18.4	3.09	265
Picea rubens	Cadillac	3	1.02	1759	4213	1004	835	28.9	20.6	3.03	251
Picea rubens	Cadillac	4	0.971	1426	4840	752	961	17.1	15.5	2.65	310
Picea rubens	Cadillac	5	0.906	2483	5128	1166	750	15.7	17.6	3.23	310
Picea rubens	Cadillac	6	0.94	2490	5686	1080	741	26.0	12.9	3.12	271
Picea rubens	Cadillac	7	0.943	1790	4838	851	797	40.8	17.2	2.55	339
Picea rubens	Cadillac	8	0.978	1458	4493	1013	760	35.1	13.2	2.81	258
Picea rubens	Cadillac	9	0.978	1424	5068	1305	710	56.3	18.2	3.04	247
Picea rubens	Cadillac	10	1.00	2413	5052	1276	780	44.2	13.0	3.25	457
Picea rubens	Cadillac	11	0.974	2255	6579	976	861	40.8	15.1	2.89	454
Picea rubens	Cadillac	12	0.942	2003	5370	871	754	48.0	14.2	2.40	445
Picea rubens	Cadillac	13	0.854	3366	4978	1357	979	49.0	12.4	2.76	644
Picea rubens	Cadillac	14	0.989	1975	6884	883	765	60.0	19.8	2.67	411
Picea rubens	Cadillac	15	1.02	2041	5136	856	862	31.2	19.0	2.41	453
Picea rubens	Cadillac	16	1.03	2855	4497	1023	761	34.7	13.7	2.75	764
Picea rubens	Cadillac	17	1.10	2395	6594	870	909	67.5	19.4	2.88	831
Picea rubens	Cadillac	18	1.17	4189	6668	1185	1045	64.1	17.3	3.49	259
Picea rubens	Cadillac	19	1.18	5197	6869	978	1005	16.7	15.6	2.53	52.7
Picea rubens	Cadillac	20	1.00	2681	7067	1133	1047	52.7	17.2	2.67	384

Table A15. Continued.

Tree Species	Water-shed Name	Sample #	N %	Ca mg/kg	K mg/kg	Mg mg/kg	P mg/kg	Al mg/kg	B mg/kg	Cu mg/kg	Mn mg/kg
Picea rubens	Hadlock	1	1.10	2062	9152	732	1033	4.92	22.4	3.64	224
Picea rubens	Hadlock	2	1.06	2432	6431	1103	733	45.0	20.0	3.15	245
Picea rubens	Hadlock	3	1.10	1195	8157	914	947	76.5	23.6	3.24	238
Picea rubens	Hadlock	4	1.15	1026	7241	1007	915	52.2	17.2	2.74	181
Picea rubens	Hadlock	5	1.22	1474	7781	1019	874	34.4	15.7	2.71	237
Picea rubens	Hadlock	6	1.08	1602	7318	1025	1116	16.4	20.1	3.34	332
Picea rubens	Hadlock	7	1.11	1987	5806	1154	876	32.6	18.0	2.91	316
Picea rubens	Hadlock	8	1.09	1588	7701	1052	883	38.9	19.6	3.46	306
Picea rubens	Hadlock	9	0.889	1046	7389	957	741	46.7	11.8	3.59	225
Picea rubens	Hadlock	10	1.12	1326	5509	902	864	28.7	10.0	2.84	180
Picea rubens	Hadlock	11	1.01	1335	6604	979	729	45.8	14.6	2.47	246
Picea rubens	Hadlock	12	1.19	862	7349	829	1050	27.7	11.8	3.79	102
Picea rubens	Hadlock	13	1.13	2012	7072	1146	816	35.7	17.3	2.71	276
Picea rubens	Hadlock	14	1.02	1970	5736	976	760	86.7	16.2	2.91	267
Picea rubens	Hadlock	15	1.20	1486	8038	801	926	50.2	22.4	2.82	243
Picea rubens	Hadlock	16	1.09	1232	7526	836	877	55.3	13.3	2.41	275
Picea rubens	Hadlock	17	1.00	1497	6960	1050	769	52.6	10.0	2.55	203
Picea rubens	Hadlock	18	1.25	2133	6973	868	952	59.6	9.63	3.53	229
Picea rubens	Hadlock	19	1.17	2496	8132	1042	849	67.7	12.5	3.35	182
Picea rubens	Hadlock	20	1.00	1766	7550	894	800	48.1	10.8	3.24	190

Table A15. Continued.

Tree Species	Watershed Name	Sample #	Fe mg/kg	Zn mg/kg	Cd µg/kg	Pb mg/kg
Picea rubens	Cadillac	1	19.9	18.2	<25	2.11
Picea rubens	Cadillac	2	26.4	22.9	28.0	3.86
Picea rubens	Cadillac	3	19.9	21.4	<25	3.24
Picea rubens	Cadillac	4	15.7	13.0	<25	2.98
Picea rubens	Cadillac	5	27.8	27.0	37	3.71
Picea rubens	Cadillac	6	30.8	31.3	<25	2.89
Picea rubens	Cadillac	7	24.2	20.8	<25	3.06
Picea rubens	Cadillac	8	35.3	21.5	<25	3.83
Picea rubens	Cadillac	9	48.6	20.0	<25	3.76
Picea rubens	Cadillac	10	40.7	27.5	27.3	3.41
Picea rubens	Cadillac	11	38.4	20.6	31.6	2.82
Picea rubens	Cadillac	12	39.4	18.2	<25	2.78
Picea rubens	Cadillac	13	31.7	32.6	57	3.26
Picea rubens	Cadillac	14	31.4	23.4	35	3.12
Picea rubens	Cadillac	15	23.2	25.2	28.6	2.31
Picea rubens	Cadillac	16	27.3	33.6	<25	2.22
Picea rubens	Cadillac	17	27.5	32.4	42.3	2.75
Picea rubens	Cadillac	18	24.9	101.0	27.5	1.63
Picea rubens	Cadillac	19	18.5	128.0	71.5	2.67
Picea rubens	Cadillac	20	27.1	30.1	25.2	2.98
Picea rubens	Hadlock	1	20.9	21.7	61.7	1.77
Picea rubens	Hadlock	2	23.3	26.9	42.7	3.24
Picea rubens	Hadlock	3	22.0	18.0	<25	3.19
Picea rubens	Hadlock	4	27.9	17.2	<25	2.23
Picea rubens	Hadlock	5	20.3	19.2	<25	3.05
Picea rubens	Hadlock	6	19.4	19.0	59.2	1.93
Picea rubens	Hadlock	7	21.0	27.1	31.6	2.18
Picea rubens	Hadlock	8	19.8	20.6	43.4	2.55
Picea rubens	Hadlock	9	21.5	19.8	<25	3.10
Picea rubens	Hadlock	10	25.3	17.3	42.8	2.50
Picea rubens	Hadlock	11	28.8	13.8	30.0	2.68
Picea rubens	Hadlock	12	18.1	17.2	<25	1.94
Picea rubens	Hadlock	13	22.2	23.9	<25	2.12
Picea rubens	Hadlock	14	20.4	34.5	47.4	2.96
Picea rubens	Hadlock	15	19.5	19.7	<25	2.80
Picea rubens	Hadlock	16	24.4	18.8	49.7	2.95
Picea rubens	Hadlock	17	28.2	17.4	<25	3.73
Picea rubens	Hadlock	18	27.7	23.4	36.3	2.83
Picea rubens	Hadlock	19	21.6	31.0	<25	3.05
Picea rubens	Hadlock	20	23.3	22.5	137.8	4.41