Red Spruce in the Understory of the Stevensville Watershed on Mt. Mansfield

By Brian Malone, Eric Blokland, Mark Grundon, and Jason Scott

Special Thanks to Chuck Vile

June 3, 1999

Abstract: The Red Spruce population has remained virtually untouched by researchers and the Forest Service for the past fifty years; in order to provide factual knowledge of the Spruce population, a study was conducted in cooperation with the Vermont Forestry Service. In the southern region of the mountain, known as the Stevensville watershed, or the Forehead, a random sampling of Red Spruce was taken every 5 chains (approximately 60 paces, or one chain is approximately 12-14 paces). The Spruce was measured for height, age, live crown, 1997 growth, and 1998 growth. The data was analyzed to determine the current population, the stratification of the Spruce, and the overall health of the population on Mt. Mansfield.

In September of 1998, the Vermont Forestry Service expressed a need for information pertaining to the Red Spruce population of Mount Mansfield. Brian Malone, a sophomore at Mt. Mansfield Union High School (MMU), contacted Chuck Vile, an employee of the Forestry Service. The project was outlined, and an independent research project of Red Spruce on Mt. Mansfield started with Eric Blokland, Mark Grundon, and Jason Scott. In late October of 1998, the first ascent of Mt. Mansfield was made on the Butler Lodge Trail in the Stevensville watershed, on the south side of the mountain. This excursion, attended by the entire group and Chuck Vile, was a precursor to the research climbs planned, and served to familiarize the team with the procedures for collecting data. Later the same month, the team ascended again, and identified all the sites to collect data; the sites are 5 chains apart, starting at the trailhead of the Butler Lodge Trail and ending just below the peak of the forehead. Twenty-five sites were tagged up to and including Butler Lodge, and five sites were marked beyond these. In early November, a third climb was completed by the team, and data was collected at every site up to Butler Lodge (sites 1-25). In the spring of 1999, the fourth and last ascent was accomplished, and the five sites from Butler Lodge to the Forehead were completed.

Spruce-Fir Forests:

The high elevations of the northeastern United States and Canada are dominated by needle-leaved evergreen trees. Theses trees are of the genera Spruce (*Picea*) and Fir (*Abies*) and make up forests called spruce-fir forests. Montane forests are made of high elevation trees, because they inhabit the mountains; however, these forests are not limited to mountains. There are similar spruce-fir forests which dominate low elevations. Spruce-fir forests can be found from the slopes of western North Carolina, to central Quebec, and into New Brunswick, Canada. This span includes Mount Mansfield, in Underhill, Vermont. Even though Spruce-fir forests vary across elevations, latitudes, and sites, the species of Red Spruce is dominant throughout. Despite the fact that the Red Spruce is restricted to the Appalachian and Adirondack Mountains and the surrounding areas, the Red Spruce species is a unifying element of these varied forests.

A spruce-fir forest is defined by a fifty percent canopy of spruce and/or fir. Red Spruce are dominant in this type of forest. The montane spruce-fir forest is the type in which the study was conducted, although Red Spruce are not limited to this type of forest. They can also be found as subdominants in forests, which are not a spruce-fir forest. Examples of this are hardwood spruce forests, and wetlands. These types of forests are not completely dominated by the spruce, but the spruce still inhabit these areas.

The montane spruce-fir forests are mountainous in topography. Because of this, characteristics of the trees such as mortality, growth rate, and height vary along the steep environmental grades. Besides these natural variations, human disturbances produce a

large amount of variation among the spruce-fir populations. One of the major disturbances brought to Red Spruce populations by humans is logging. The response of the Red Spruce to environmental stresses and other environmental changes vary by elevation, site, and history of the area. The major environmental causes of variation in eastern spruce-fir forests are temperature and moisture, which do occur form humans. Elevation is matched with physical factors. It is used universally as a surrogate for change in the physical environment while conducting vegetation studies (4). Latitude, topography, disturbance, and site variables also influence on the vegetation.

There is a common model of variation in upland forests in which spruce and fir have overlapping distributions on the elevational gradient, but spruce reaches it's maximum dominance at lower elevations than fir (4). In the transition from hardwood to conifer dominance, Red Spruce overlaps with Yellow Birch; however, fir increases its dominance with elevation, and dominates in nearly pure strands above the elevation in which Red Spruce can exist. Dominance of spruce tends to occur on steep, rocky, convex slopes, and along rocky streambeds. The three phases of the montane spruce-fir forests are (1) spruce-fir/spruce, (2) spruce-fir/fir, and (3) spruce-fir/Krummholz. Mountains with treelines (the elevation where the growth of plants is minimal to non-existent) have the trees exposed and they decrease in stature with elevation. The average size decreases, and stem density increases from low to high elevation as well as from protected to exposed habitats. This low vegetation is known as Krummholz.

Montane spruce-fir forests are the only part of the forests which are dominated by spruce and fir. There are also low elevation spruce-fir populations. They are defined as spruce-fir stands that are below the normal elevation of the montane spruce-fir forest, or

the occurrence of spruce and fir in hard wood. Forty-percent of northern New England and New York is made up of spruce-fir forests, but only ten-percent of this is montane spruce-fir. Spruce-fir populations in low elevation can occur in northern Vermont from sea level to 500 m above sea level; however, in southern Vermont they are limited to wet areas, and 1000 m (or more) above sea level. These low elevational spruce-fir forests occur on damp or rocky substrates. Red Spruce can occur at low elevations, on poorly drained sites, such as minerotrophic (minerals for food) wetlands, ombritrophic bogs, lake shores, and stream sides. Red spruce also occur on dry, nutrient-poor, rocky or shallow soils, and ridges, steep slopes, and ravines.

The ecotone (the ecological variability) between spruce-fir and adjacent ecosystems is abrupt. One hypothesis is that this sharp contrast is due to a sporadic frequency of clouds. The clouds provide a source of moisture for Red Spruce. Spruce remain in clouds from ten-percent to forty-percent of their growing period. There are also the physical factors created by the differences between conifers and deciduous trees. Conifers have large effects on light because of the year-round shade that they produce. The soil is also affected by the trees because they make it acidic, and form physically resistant ecological litter. These physical differences add to the sharp contrast between ecotones of deciduous trees and coniferous trees. Logging resulted in a universal decrease of Red Spruce populations in mixtures of spruce and hard wood. This also sharpened the spruce-fir-deciduous boundary.

Natural and human disturbances can affect the spruce-fir populations. Large scale disturbances, such as avalanches, can wipe out whole spruce-fir populations. After a disturbance like this, trees will take over that have shorter life spans. Birch Pin Cherry

and some forms of shrubbery are examples of what might take over. These species are not the climax community, however; they do eventually give way to Red Spruce and other conifers that are better suited. The plants that take their place after a disturbance generally have shorter life spans than those originally situated in the disturbed area. The trees that make up a climax community will have longer lives. The average Red Spruce lives for 200 years, and the record is 430 years. Balsam fir average 100 years, and the oldest ever lived for 220 years. Some of the most predominant causes for disturbance are insects, ice, and wind. Montane forests are subjected to hurricane winds on a thousand year cycle, though it may be more frequent than this. The insects can create large mortality rates among the trees. The spruce bud worm (*Choriosteneura fumiferana*) feeds on both spruce and fir, but prefers balsam fir. The spruce beetle (*Dendroctonus rufipennis*) also contributes to many deaths in the spruce-fir population. Wide-spread winter injury has occurred in Red Spruce forests eight times in the past 120 years.

One of the most devastating disturbances that humans create is logging. Red spruce have been desired by logging companies since the 1700's. By 1849 Red Spruce were being cut for wide spread uses. In the year 1875 spruce was first used to manufacture paper; by 1880, large scale cutting of Red Spruce began. In the 1900's they were being use for planes and automobiles for World War I. The efforts to create The Great Smokey Mountains National Park brought an end to cutting the largest remnants of the old-growth spruce-fir in 1927. During the mechanized phase of logging, much damage occurred due to clear-cutting, logging slash fires, and soil erosion. In 1930 the forests were exploited the most. Red Spruce density was reduced by fifty-percent. As a result of the wide spread destruction of spruce, there was a conversion of spruce-fir

to fir-spruce, and the loss of the spruce in hardwood zones. After the disturbances of logging Blackberry (*Rubus*) would immediately become the dominant tree, increasing it's density 5 to 10 times (32). After this, a Fire Pin Cherry, Birch, or Quaking Aspen would take over. Spruce is susceptible to logging slash fires because of their thin bark and shallow roots. After cutting light levels were high, and this permitted hardwood competition. This eventually led to select cutting.

History of the Red Spruce Population on Mt. Mansfield:

Mt. Mansfield remained virtually untouched by humans until the Civil War era. Trappers and settlers, as well as the movement of troops during the Revolutionary War did little to disturb the ecology in the mountains of Vermont.

In the mid-1800's, Mt. Mansfield faced the first loggers. A saw mill was set up at a site that can still be seen on the road leading up to the Butler Lodge trailhead. The sawmill was used heavily, and many of the Red Spruce of the mountain were logged. This was the first and possibly the most destructive logging to occur on the mountain in terms of damage to the Red Spruce population.

Shortly after, a massive fire swept through this area of the mountain. The area hardest hit was the Claybrook Watershed, but the extent of the fire damaged the Stevensville watershed, the focus area of our study. As is true with many recovering forests during this period, a numerous population of Black Cherry sprang up in the ashes. Black Cherry is unique in that it can only grow in areas that have been disturbed, with events such as a fire.

By the 1900's, farming was common in the area, and in the year 1914, the bottom of the watershed, at the current Butler Lodge Trailhead, was entirely bare; it was a field, used for crops.

When the Depression hit the United States, the Civilian Conservation Corps (CCC) began work on all regions of Mt. Mansfield. In the 1930's they harvested (thinned) much of the area, and released many of the diminishing Red Spruce, which was struggling to reestablish itself in the relatively new community. The harvesting worked, because the Red Spruce population rose steadily in numbers until the 1950's.

When World War II struck America, the forests of Mt. Mansfield were logged, including the Red Spruce. The wood that was processed went to the war cause; it was used to build planes to go into combat.

As stated, the population of Red Spruce went into a decline in the 1950's. The Red Spruce never had a chance to recover from the tumultuous years it had endured. Between the logging, the fire, and the farming, it never had a chance to reestablish itself firmly and properly.

In 1957 the Forest Service stepped in. During the winter, the overstory was thinned to allow for the growth of the Red Spruce. The thinning was only done under 2300', and the brush was cleared from the area by horse.

In the 1960's, the Black Cherry began to decline. The forests of Mt. Mansfield remained untouched by loggers, the Forestry Service, and other natural disasters for the next 15 years.

A study done by the Forestry Service in 1973, one of the few that have been done on this portion of Mt. Mansfield, confirmed that the population of Red Spruce had

increased. The survey found many Red Spruce, all in clumps of three, and usually one of the three was dying. Furthermore, many of the trees were over 100 years old, suggesting that these trees, or this area, had endured the logging and disasters of the early nineteenth century. It is likely that the disturbances did not reach the upper elevations.

Once again, in 1973, the Forestry Service went into the area and thinned the overstory. In 1973, the thinning was done in the summer. In 1974, the forest was thinned again, but this time in the winter. All of this thinning was assisted by a skidder.

By 1990, the last existing Black Cherry had disappeared; in 1998, the Youth Conservation Corps began work on the Red Spruce population. They cleared much of the debris around the Red Spruce in the understory away to allow these trees to grow more freely.

Hypothesis:

The Red Spruce population in the Stevensville watershed on Mt. Mansfield is expected to be low; in addition, the Red Spruce are expected to be young due to the intense logging that occurred in the area. The 1997/1998 (or yearly) growth is expected to be minimal.

Assumptions:

1. That the Red Spruce selected for sampling were an accurate representation of the entire Red Spruce population at this level of elevation.
2. That each tree selected is a Red Spruce.
3. That the trees sampled are unaffected by unnatural factors (i.e. humans damaging or altering the tree).
4. That each station is accurately marked at the correct elevation.

Experimental Procedure:

Materials:

- Measuring stick, centimeters and inches
- Data tables
- Marking tape
- Compass
- Guide to positions of each station
- Trail map
- Map to elevations and stratification of Red Spruce

- Trail map
- Map to elevations and stratification of Red Spruce

The area of study was limited to the Stevensville watershed on the south side of Mt. Mansfield. The Butler Lodge Trail was used as a guide, and the parameters of the sampling area were approximately 200 feet to each side of the trail. Each station was 5 chains further up the trail than the previous station, and sampling of three trees was taken at each station. To collect data, a Red Spruce must be found, within the established limits, and must be below head height. Once a tree has been located, the following measurements were taken: the 1997/98 growth, height of the entire tree, the age of the entire tree, the height of the live crown, and the live crown ratio. The 1997 growth was found by measuring, in centimeters, the distance between the first bunch of protruding branches (usually three) from the top of the tree, and the second bunch of protruding branches; this measurement is the entire height that the tree grew in the 1997 growing season. To find the 1998 growth, find the first bunch of branches, measure from this point to the top of the tree; this is the entire growth of the tree in 1998. The height of the entire tree is found by measuring from the floor of the forest, as close to the roots as possible, to the very tip of the crown. Age is determined by counting the number of bunches of branches that protrude from the tree. Each bunch represents one year in the growth of the tree. For most of the trees, live crown, or the section of the tree that is alive, will end about half to two-thirds of the way down the tree, and the age will be hard to detect due to the lack of branches to count. In this case, count the number of branches easily recognized, and assume that the tree has lived longer than this, denoting this by a

the point where the branches no longer have any needles on them, or where the live crown ends. To find the live crown ratio, divide the live crown by total height of the tree.

Sample Calculations:

To find the live crown ratio:

$$\text{Live Crown Ratio} = \frac{\text{Live Crown}}{\text{Height}}$$

$$\text{Live Crown Ratio} = \frac{30\text{ cm}}{39\text{cm}} = 10/13$$

To convert inches to centimeters:

Inches x 2.5 = Centimeters

To convert centimeters to inches:

$$\frac{\text{Centimeters}}{2.5} = \text{Inches}$$

Results:

The hypthesis stating that the population of Red Spruce would be low due to logging or some other factor was not conclusively proven; in some areas the Red Spruce were abundant, while in others they were scarce. From Butler lodge to the Forehead, many of the spruce were too large in height to measure, and were not included in the data collected. The Red Spruce found in the lower elevations are relatively younger than the ones found closer to the summit. They are mostly under 25 years of age. The 97/98 growth on most of the trees sampled is dwarfed, not meeting the six inch requirement for a healthy Red Spruce. The hypotheses were proven correct in this aspect.

Works Consulted

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LOCATION: Buttler lodge, Wampahoofus, and Maple Ridge trail trails on Mount Mansfield, Vermont

Live Crown Ratio	1997 Growth	1998 Growth	COMMENTS
13/24	1/2.5	1.13/2.8	Next to river
33/56	.7/1.75	.7/1.75	
3\5	.75/1.88	1/2.5	Valley overlooking river
30/71	.4/1	.4/1	
5\7	.5/1.25	1/2.5	Area is more exposed to sunlight
9\14	1.2/3	.8/2	
47/53	2.25/5.625	3.5/8.75	Very windy area
2\3	1/2.5	1.6/4	
24/49	1/2.5	1/2.5	
90/107	1.2/3	.8/2	
80/93	4\10	5.5/13.75	Open area / Facing valley
9\14	1.6/4	1.6/4	
1\1	1.75/4.375	1/2.5	Edge of ravine / Tree 3- wilting
4\5	2.4/6	1.6/4	
8\11	2.5/6.25	1.5/3.75	Trees 1 and 2 almost ontop of eachother
21/25	1.6/4	2.8/7	
29/55	1/2.5	.75/1.875	Tree 1- wilted
7\9	1.6/4	.8/2	
1\1	4.5/11.25	3/7.5	
137/177	2\5	6.6/16.5	
55/73	2.25/5.625	2\5	Trees have very long branches
6\7	2\5	2.8/7	
36/65	.75/1.875	.5/1.25	
21/25	1.5/3.75	2.5/	Forest consists of almost totally connifers
85/91	.4/1	.8/2	Red spruce scarce, many hemlock (trees 1 and 2 on riverbed.
140/183	1/2.5	1.8/4.5	Red spruce in understory scarce, but many giant, older red spruce in overstory.
14/29	3.6/9	4\10	Only three red spruce in understory that could be found.

EXTENDED-3 DESCRIPTION:

The Red Spruce understory has thinned out and there are virtually no Red Spruce trees in the understory. However, there is a vast number of Red Spruce in the overstory, towering above us. These are identified by the same means all other Red Spruce have been identified. Because of their size, we are unable to take measurements. This, beginning at Buttler Lodge is the beginning of a different stage of Red Spruce on the mountain.

EXTENDED-4 DESCRIPTION:

Many of the same things from E3 are seen at this level, though tree height is decreasing while age still remains older than those observed at lower elevations.

ALPINE ZONE / EXTENDED-5 DESCRIPTION:

At this elevation, on the forehead of Mount Mansfield, the red spruce dominate the tree population, though due to extreme weather, are extremely dwarfed. These trees are less than waist-high, yet appear significantly older than others studied. These trees obviously suffer severe conditions, this is evident in size and yearly growth.

STATION AVERAGES

Station #	Age	Live Crown Ratio (%)	1997 Growth (in/cm)	1998 Growth (in/cm)
1	20+	38.39	1.66/4.17	1.87/4.68
2	21.3+	50.5	.7/1.75	.7/1.75
3	19.3+	74	.872/2.18	.91/2.29
4	21.3+	40.27	1.26/3.16	3.6/9
5	16.3+	82.14	.92/2.29	.91/2.29
6	21+	78.11	1.73/4.33	1.33/3.33
7	20+	62.9	1.75/4.375	2\5
8	30+	75.8	.87/2.16	1.8/4.5
9	25+	59	1.12/2.8	.625/1.56
10	20+	85.27	.93/2.33	.93/2.33
11	22+	87.65	2.8/7	2.4/6
12	28+	74.85	1/2.5	1.46/3.66
13	22+	82.5	1.5/3.79	1.16/2.9
14	29+	70.3	1.6/4	1/2.6
15	19.3+	79	1.41/3.54	1.25/3.125
16	27+	82.9	2\5	2.26/5.6
17	21.3+	80.43	1.83/4.58	1.15/2.875
18	23.3+	78	2.26/5.66	1.46/3.66
19	18.6+	100	3/7.7	3.83/9.5
20	26.3+	73	1.53/3.83	4.2/10.5
21	21+	80	2\5	1.83/4.58
22	33+	74.86	2.53/6.33	3.2/8
23	23.6+	63.1	1.25/3.125	1/2.7
24	20.6+	76.75	1.41/3.54	1.5/3.75
25	16.3+	85.64	1.8/4.5	2.26/5.66
E1	23+	33.6	1.93/4.83	2.6/6.5
E2	19.3+	68.7	3.6/9	3.46/8.66
E3	NA	NA	NA	NA
E4	NA	NA	NA	NA
E5	~40-65	Mostly 100	.2/.5	.2/.5

RED SPRUCE REIGON AVERAGES

*On Mount Mansfeild, three distinct regions of red spruce were identified.
Reigon 1- From Butler Lodge trail head to Butler Lodge
Reigon 2- From Buttler Lodge to just below Forehead
Reigon 3- Alpine zone, forehead reigon

REGION 1 AVERAGES:

Age	Live Crown Ratio (%)	1997 Growth (in/cm)	1998 Growth (in/cm)
21.78	68%	1.63/4.0	1.95/4.875

REGION 2: Due to the characterization of this reigon, it was impossible to take measurements.

REGION 3 AVERAGES:

Age	Live Crown Ratio (%)	1997 Growth (in/cm)	1998 Growth (in/cm)
~40-65	Almost all 100	.2/.5	.2/.5

*NOTE: Since the third region began basically at the top, only one set of measurements was taken. (So generalizations were noted)

Jason Scott
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Jay2007@aol.com

To whom it may concern, *10/21/98*

We would like to conduct a study on the Red Spruce population on Mt. Mansfield. This is part of a year long project due in June of 1999. We are in a biology honors class at Mt Mansfield Union High School and we are required to work on a project of whatever we want as long as it somehow pertains to biology. We wanted to do something where we had to be outdoors. It was suggested that we try to do something with the conifers on the mountain. That is when we contacted Mr. Chuck Vile. He told us that conifers on the mountain was to broad of a topic. He suggested that we could study the differences in population, size, and other elements with Red Spruce trees. We decided to use his suggestion. So now we are requesting permission to be able to study Red Spruces along the Butler Lodge Trail. We will be going to pre - marked stations and searching for the first three Red Spruces that we come across. We will be measuring their overall height, their 1998 growth height, and their live crown's. This study will be done in the fall of 1998. We hope to observe and record the pattern and nature of the Red Spruce regeneration on Mt. Mansfield State Forest's west side. The information that we collect will be used by the foresters of that area. We ask that you could please grant us a permit to conduct the research. Thank you for your time.

Sincerely,

Jason R Scott: Mark S Grundon:

Brian P Malone: Eric H Blockland:

Vermont Monitoring Cooperative Application for 1998

For Monitoring and/or Research on Mt. Mansfield

Applicant Names: **Telephone #:**

Brian Malone	(802)-899-2414
Eric Blokland	(802)-899-2596
Jason Scott	(802)-899-2960
Mark Grundon	(802)-899-3803

Applicant Addresses:

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05489

Eric Blokland
3 Beachwood lane
Jericho Vt
05465

Jason Scott
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Underhill Vt
05489

Mark Grundon
77 Foothill Dr
Jericho Vt
05465

Organization/Affiliation: **Honors** biology students at Mount Mansfield Union High School.

Project Title: **A** Study on Red Spruce in the Under Story.

Project Description:

Our project takes place on the south side of Mount Mansfield. Beginning at the parking lot and ending at the forehead on top of the mountain. We will be gathering data from as many as 34 checkpoints along the Butler Lodge Trail and the Wampahoofus Trail. We will be conducting a study on the growth and aging of red spruce in the understory in difference in elevation. On the Butler Lodge Trail there are markers spaced five chains apart that we will be utilizing as the majority of our checkpoints. From Butler Lodge up there are no markers that we know of, we will be creating our own checkpoints along the Wampahoofus Trail pacing out five chains between each point and marking these points with red ribbon. At each checkpoint we will take a compass reading to find out which direction north is in, and walk along the contour either in a north or south direction. It is the first three red spruce trees (located only in the understory) that we will gather information on. We will measure its total height, crown height, 1997 and 1998 growth, and the trees approximate age. During this study we will be leaving nothing behind or changing the site in any way other than footprints.

Duration of Project: We will be conducting our studies at various times between approval (may begin prior too with verbal permission) and June 1, 1999.

State of Vermont

AGENCY OF NATURAL RESOURCES

Department of Fish and Wildlife
Department of Forests, Parks and Recreation
Department of Environmental Conservation
State Geologist

Department of Forests, Parks & Recreation
111 West St
Essex Jct., VT 05452
Tele: (802)879-6565 5687 direct
FAX: (802)878-5192

Dear Mt. Mansfield Union students,

→ sent to Brian

Enclosed is the signed application to conduct your study on Mt. Mansfield. Hope your work is going well.

A question: The trails you will work off are Butler Lodge Trail to the lodge, then Wampahoofus Trail to Maple Ridge Trail, then up to the Forehead from there?

When you have finished collecting data, could you send me copies of your data sheets or computer spreadsheets for archiving. I'd also like a copy of your final report to archive and include in our VForEM Annual Report (which summarizes results of research on the mountain for each year).

If there is data from the mountain that you would like to include in your analysis or report (such as weather data, air quality, forest species composition, etc), give me a call and I can tell you what we have in our Data Library and take information on what you need.

I will include you all as VForEM Cooperators, and your names and project will appear in our Directory of Cooperators, as well as on our web site.

Good luck. Don't hesitate to contact me if you have questions.

Sincerely,

Sandy Wilmot

Sandy Wilmot
VForEM Monitoring Director

Specific Study Area: From the Stevensville rd parking lot to the Mount Mansfield forehead, along the Butler Lodge Trail and the Wampahoofus Trail.

*Our data will be able to tell age differences and grown in different elevations on Mount Mansfield. Since we were given this project by the forest service, they will be able to use our information in their records.

*Our data will be available to anyone who wishes. This data will be our calculations.

Applicant signatures

Date: 12/15/98

Terms of approval (if any):

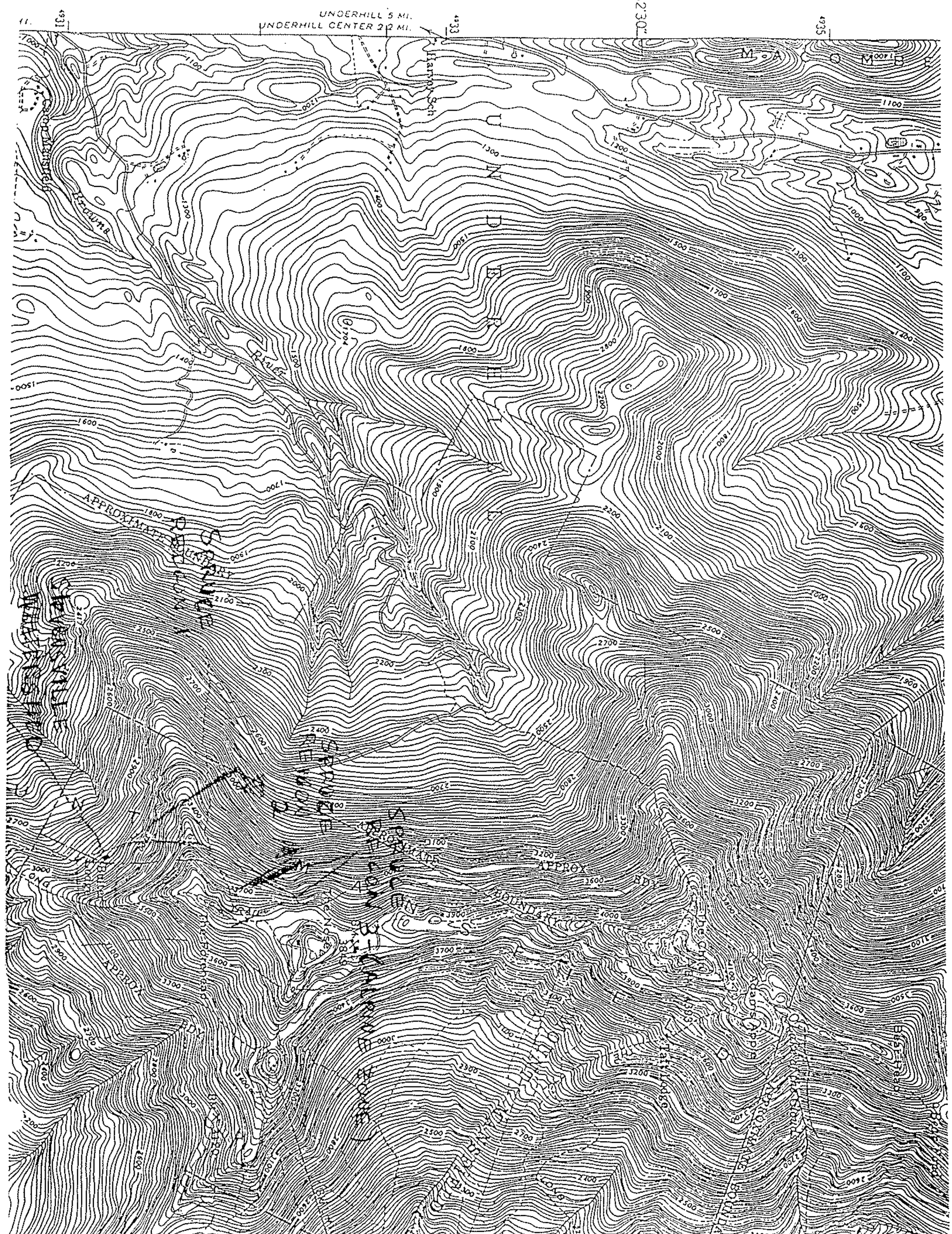
Project approval:

VforEM Official signatures

Date: 5/5/99

Location approval:

Date: 5/5/99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UNDERHILL CENTER 2½ MI.
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Harmon Sch
Browns River
APPROXIMATE BOUNDARY
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SPRUCE REGION 3 (ALPINE ZONE)
SPRUCE REGION 4
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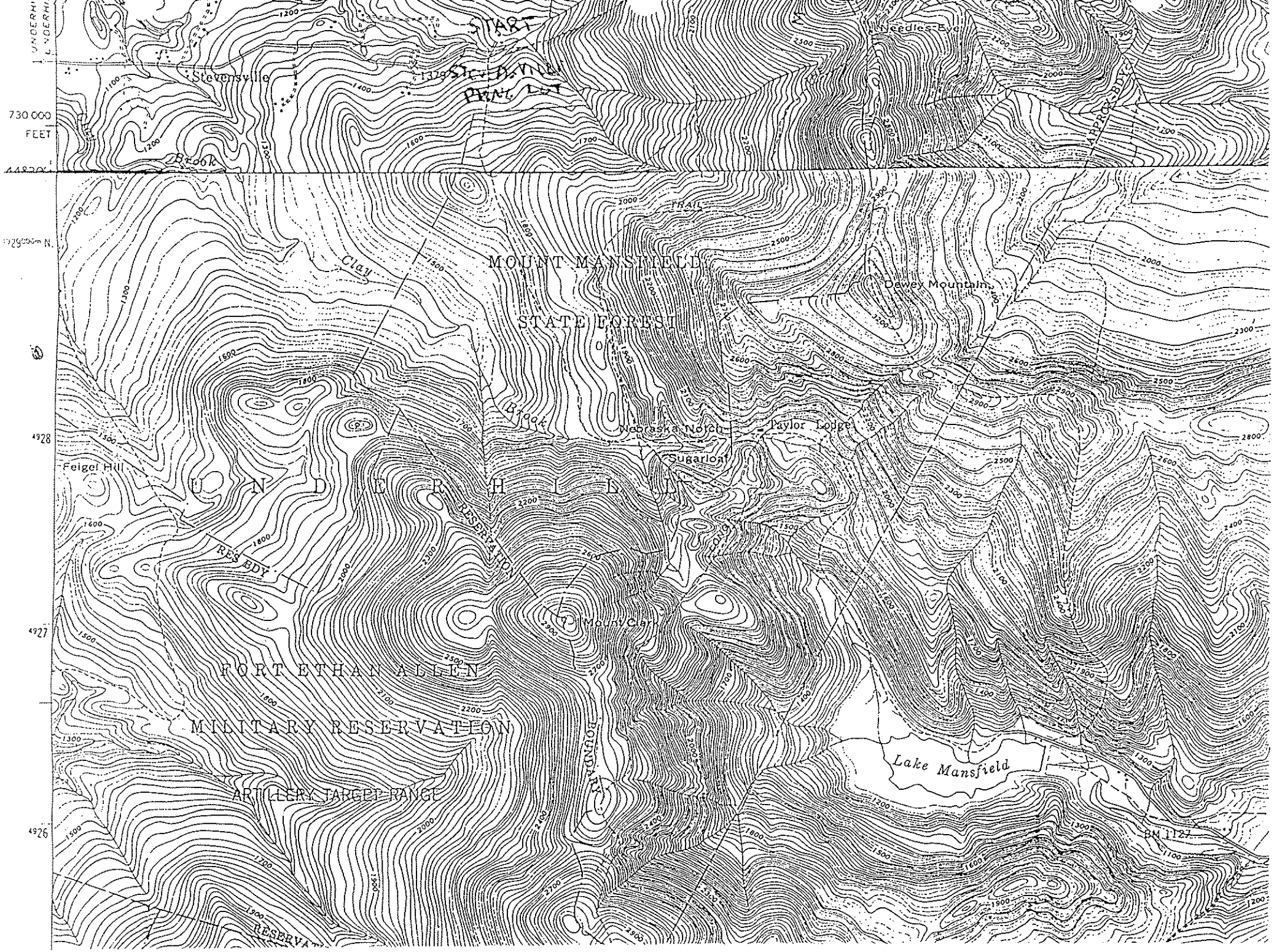
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STATE FOREST
Clay
TRAIL
Nebraska Notch
Taylor Lodge
Sugarloaf
Feigel Hill
UNDERHILL
RESERVATION
RES BDY
Mount Clark
FORT ETHAN ALLEN
MILITARY RESERVATION
ARTILLERY TARGET RANGE
Lake Mansfield
BM 1127
4928
4927
4926

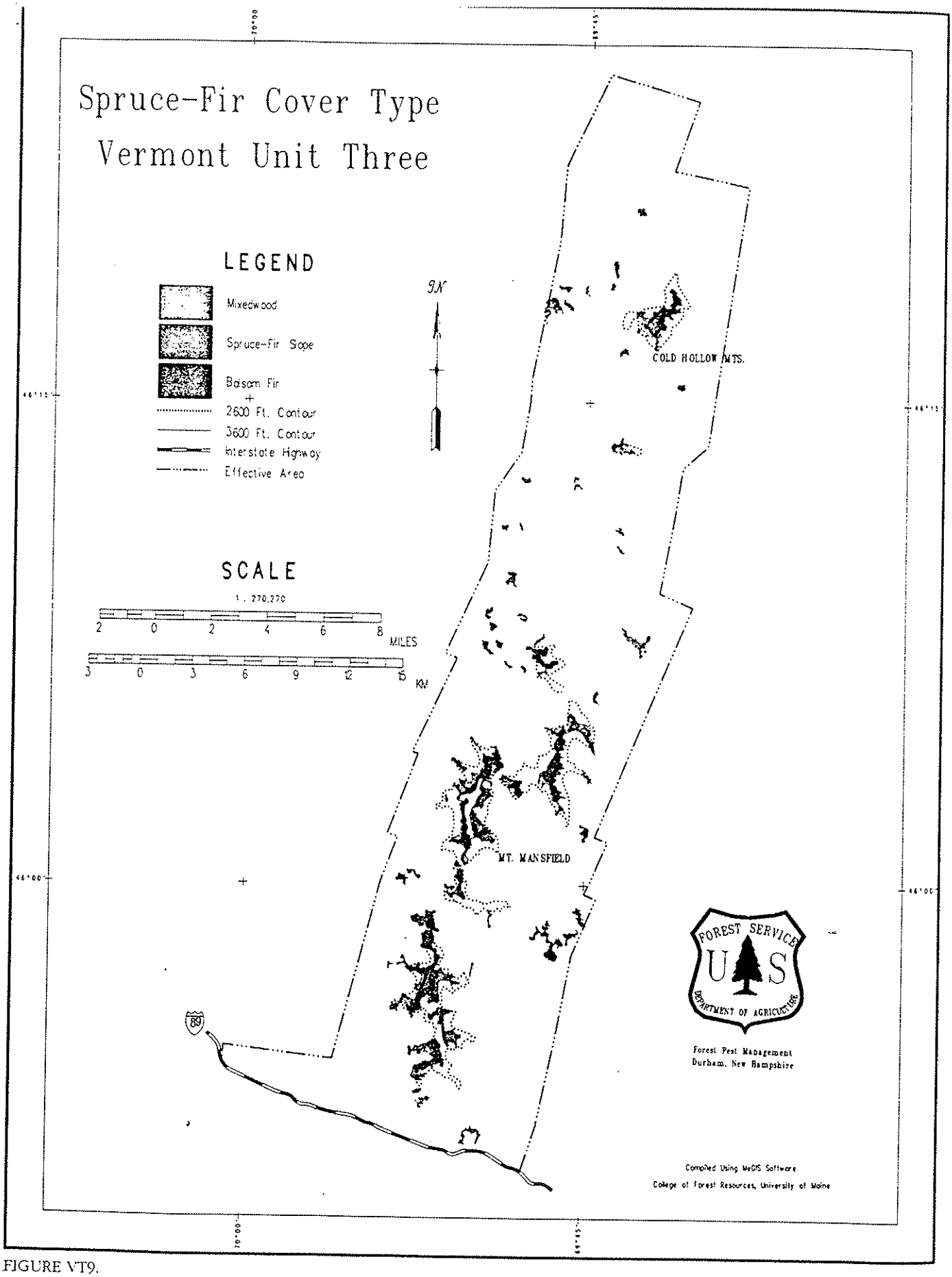
Spruce-Fir Cover Type
Vermont Unit Three
LEGEND
Mixedwood
Spruce-Fir Slope
Balsam Fir
2600 Ft. Contour
3600 Ft. Contour
Interstate Highway
Effective Area
SCALE
1 : 270,270
2 0 2 4 6 8 MILES
3 0 3 6 9 12 15 KM
COLD HOLLOW MTS.
MT. MANSFIELD
89
FOREST SERVICE
U S
DEPARTMENT OF AGRICULTURE
Forest Pest Management
Durham, New Hampshire
Compiled Using MaGIS Software
College of Forest Resources, University of Maine

FIGURE VT9.

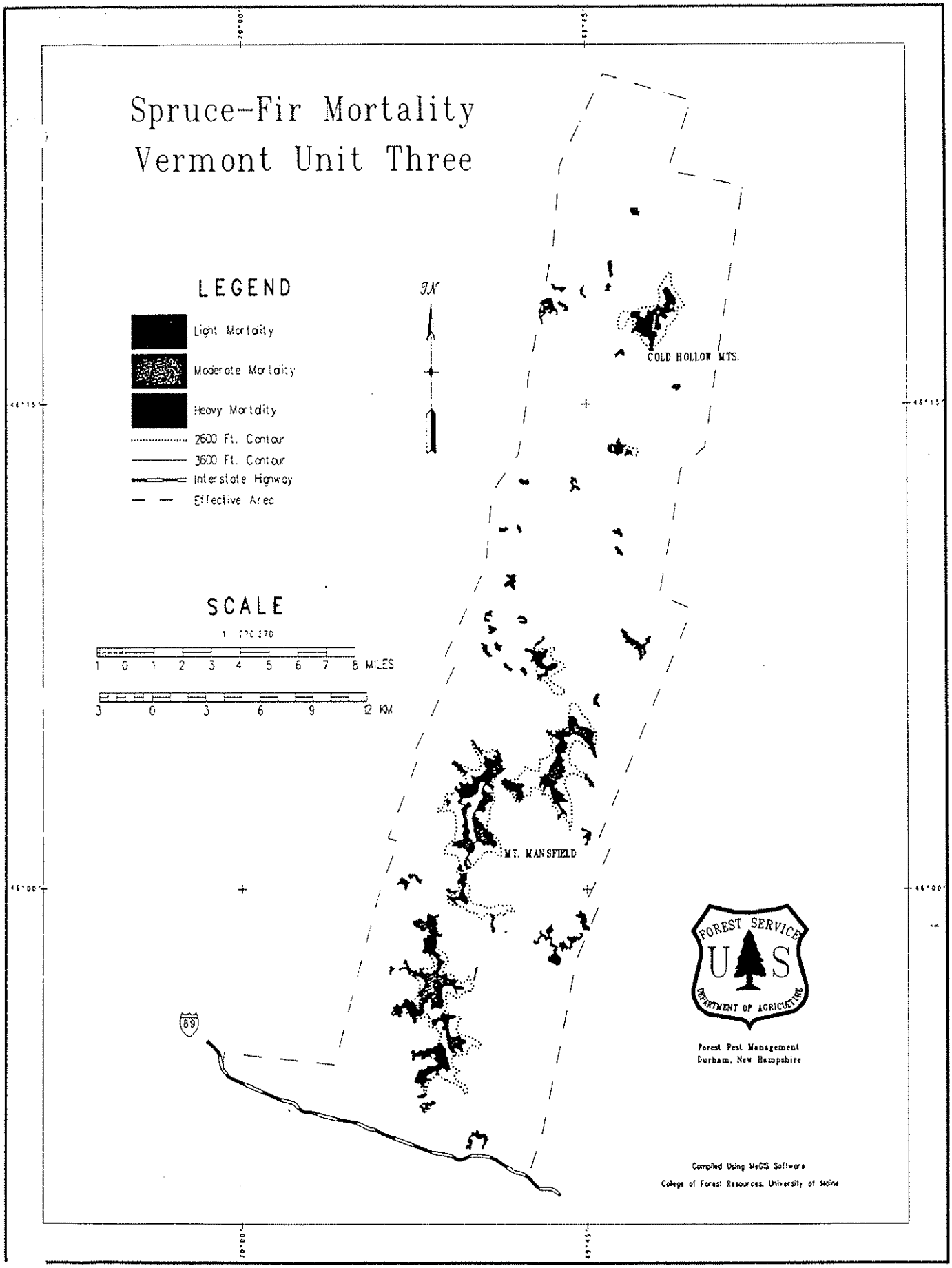
Spruce-Fir Mortality
Vermont Unit Three
LEGEND
Light Mortality
Moderate Mortality
Heavy Mortality
2600 Ft. Contour
3600 Ft. Contour
Interstate Highway
Effective Area
SCALE
1 270 270
1 0 1 2 3 4 5 6 7 8 MILES
3 0 3 6 9 12 KM
COLD HOLLOW MTS.
MT. MANSFIELD
89
FOREST SERVICE
U S
DEPARTMENT OF AGRICULTURE
Forest Pest Management
Durham, New Hampshire
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FIGURE VT10.