

## TREE PHENOLOGY MONITORING ON MOUNT MANSFIELD - 1995

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### ABSTRACT

Monitoring of bud development, and fall color and leaf drop began in 1991 on sugar maple at one elevation (1400') on Mount Mansfield. The following year, a higher elevation was added (2200') and two additional hardwood species, yellow birch and American beech. In 1995, red maple and white ash were added at the 1400 foot elevation to provide broader information on early and late season bud development. The purpose of this monitoring effort was to gather baseline information on these fundamental tree processes. Understanding the timing of developmental stages in relation to weather phenomena (such as early fall frost) and insect pest activity (such as pear thrips feeding in sugar maple buds) improves our knowledge of inter-relations between tree physiology and stress events.

Bud development and leaf expansion followed a similar pattern to that of 1994. For most species and elevations, development was slower and later, especially when compared to 1992 and 1993. At the lower elevation site where 5 species are evaluated, the progression of bud development among species shows sugar maple, red maple and yellow birch all reaching budbreak together, then beech, and finally ash. The progression toward full leaf expansion shows sugar maple first, followed by red maple and beech, then yellow birch, and finally ash.

In general, fall color at the 2200 foot elevation was slightly earlier than in the past 3 years, while at lower elevations (1400 feet), color development was similar to past years. This may be a symptoms of stress experienced in the spring and early summer due to drought conditions. Full color (50% of crown with color) occurred at similar dates for sugar maple, yellow birch and beech at both elevations.

Comparisons between species at the 1400 foot elevation site show that ash is the first of these species to reach full color and drop its leaves. Sugar maple is the last species to reach full color, and has significant leaf drop similar to red maple and yellow birch.

## INTRODUCTION

Monitoring of bud development, and fall color and leaf drop began in 1991 on sugar maple at one elevation (1400') on Mount Mansfield. The following year, a higher elevation was added (2200') and two additional hardwood species, yellow birch and American beech. In 1995, red maple and white ash were added at the 1400 foot elevation to provide broader information on early and late season bud development. The purpose of this monitoring effort is to begin gathering baseline information on these fundamental tree processes.

Understanding the timing of developmental stages in relation to weather phenomena (such as early fall frost) and insect pest activity (such as pear thrips feeding in sugar maple buds) improves our knowledge of inter-relations between tree physiology and stress events.

## METHODS

### BUD DEVELOPMENT

Bud development is recorded twice weekly from early April through mid-June using visual ratings as seen through a high powered spotting scope. Five mature trees and 5 saplings of sugar maple, yellow birch, American beech, red maple and white ash are monitored at the 1400 foot elevation site at the Proctor Maple Research Center for a total of 25 trees and 25 saplings. Sugar maple, yellow birch and American beech are monitored at the 2200 foot elevation in the Underhill State Park for a total of 15 trees and 15 saplings at this site. Bud stages are recorded from the upper canopy, lower canopy and regeneration from dormancy through full leaf expansion (Table 1a & 1b). Descriptions of sugar maple bud stages (Skinner & Parker, 1994) have been modified for the other species to allow between-year comparisons of bud and leaf development. Flower bud stages are rated, but not all trees have flower buds each year and in the same years, so trend information is limited and will require many more years of data collection.

### FALL COLOR AND LEAF DROP

Initial crown ratings are recorded on the same sample trees and saplings in late July to establish a baseline for trees with full foliage. From mid-August through October, trees and saplings are rated for color and leaf drop. Color is rated in 5% categories using the North American Maple Project definitions for discoloration (color other than green). Leaf drop was initially measured using crown dieback (defined here as the percent of branches without foliage) and foliage transparency ratings as per the National Forest Health Monitoring Program. Crown density was added in 1995 to more accurately capture leaf drop. A measure of the density of the tree with no foliage (leaf-off density) is taken late in the fall once all the leaves are gone, or in the spring before leaf out. Using both the full leaf-on and leaf-off density ratings, the percent leaf drop is calculated. In future years, density will replace dieback and transparency ratings in monitoring leaf drop.

Table 1a. Vegetative bud stages for sugar maple, yellow birch, American beech, red maple and white ash

VEGETATIVE STAGE	SUGAR MAPLE	YELLOW BIRCH	BEECH	RED MAPLE	WHITE ASH
V0	bud dormancy	bud dormancy	bud dormancy	bud dormancy, 2-3 scale pairs	bud dormancy, 2 scale pairs
V1	initial bud swell	initial bud swell	bud lengthening	initial bud swell, 3-4 scale pairs	initial bud lengthening, 3 scale pairs
V2	bud elongation	buds fatter and slightly green	buds wide at base, exaggerated point at tip	bud swell and elongation, 4 scale pairs	bud elongation and swelling, 4 scale pairs, smooth
V3	buds in green tip stage		bud scales separating and bending back slightly	buds in green/yellow tip stage, 5 scale pairs	buds in green stage, 4 scale pairs with end scales wrinkled like leaf tip
V4	bud break, leaf tips expanded beyond the bud tip	bud break, leaf tip exposed, appears fuzzy	bud break, leaf tips exposed	budbreak, leaf tip exposed	budbreak, wrinkled leaf tip exposed
V5	extended bud break, leaves not yet spread apart	extended bud break	extended bud break	extended budbreak, leaves show beyond scales	extended budbreak
V6	initial leaf emergence, leaves breaking away from tip	initial leaf emergence, leaves breaking away from tip	initial leaf emergence, leaves breaking away from tip	initial leaf emergence, leaves breaking away from tip	initial leaf emergence, leaves breaking away from tip
V7	initial leaf expansion, leaves unfolding, broadening, elongating, wrinkled, individual leaves not yet fully expanded	initial leaf expansion, leaves unfolding, broadening, elongating, wrinkled, individual leaves not yet fully expanded	initial leaf expansion, leaves unfolding, broadening, elongating, wrinkled, individual leaves not yet fully expanded	initial leaf expansion, leaves unfolding, broadening, elongating, wrinkled, individual leaves not yet fully expanded	initial leaf expansion, leaflets spread apart on petiole and begin elongating, broadening and expanding, individual leaves not yet fully expanded
V8	full leaf expansion, flattened surface without wrinkles, may not be full size	full leaf expansion, flattened surface without wrinkles, may not be full size	full leaf expansion, flattened surface without wrinkles, may not be full size	full leaf expansion, flattened surface without wrinkles, may not be full size	full leaf expansion, flattened surface without wrinkles, may not be full size

Table 1b Flowering bud stages for sugar maple, yellow birch, American beech, red maple and white ash

Flower Stages	Sugar Maple- Male & Female	Yellow Birch- Male (catkin)	Yellow Birch- Female	Beech- Male	Beech- Female	Red Maple- Male	Red Maple- Female	White Ash- Male	White Ash- Female
F0		dormant				dormant rounded buds in clusters	dormant rounded buds in clusters		
F1	initial bud swell	initial bud swell		initial bud swell, buds wider at base than vegetative buds	initial bud swell, buds wider at base than vegetative buds	initial bud swell, 3 scale pairs, orange hairs at tip	initial bud swell, 3 scale pairs, orange hairs at tip	initial bud development, side buds open, 2 scale pairs	
F2	bud elongation, buds more rounded at tip than vegetative buds	bud elongation		bud elongation and continued swelling					
F3	green tip stage	full bud elongation		bud separation					
F4	bud break, flower tips show expanded beyond bud tip	bud break, stamens show below scales	bud break, flower tips show beyond bud scales	bud break, green flower shows		bud break, bud scales crack open	bud break, bud scales crack open	bud break, yellow or red stamens exposed	
F5	initial flower expansion, flower bundle expands beyond bud scales		initial flower expansion, flower stalk fully exposed, slender	initial flower expansion, flower bundle on stalk extends beyond bud scales		initial flower expansion, red stamens expand beyond scales	initial flower expansion, red stigma extends beyond scales	initial flower expansion, stamens extend beyond scales	
F6	full flower expansion and pollen dispersal	full flower expansion and pollen dispersal	full flower expansion, stigmas red, flower stalk swollen	full flower expansion, yellow stamens extended, pollen dispersed	full flower expansion, red stigmas extended (small flowers among leaves)	full flower, yellow stamens, pollen dispersed	full flower, flower hangs down on stalk, stigma red	full flower, pollen released	full flower, small flowers with red stigmas on yellow flower stalk
F7	flower senescence and drop	flowers brown and drop	stigmas brown or absent	flower senescence and drop		flower senescence, stamens brown, drop		flower senescence and drop	
F8	initial seed development		initial seed development		initial seed development		initial seed development		initial seed development

Leaf drop at each visit (%) =

$$\frac{((\text{full leaf-on density} - \text{density at visit}) / (\text{full leaf-on density} - \text{full leaf-off density})) \times 100}{}$$

## RESULTS

### SPRING PHENOLOGY

Bud development and leaf expansion followed a similar pattern to that of 1994. For most species and elevations, development was slower and later, especially when compared to 1992 and 1993.

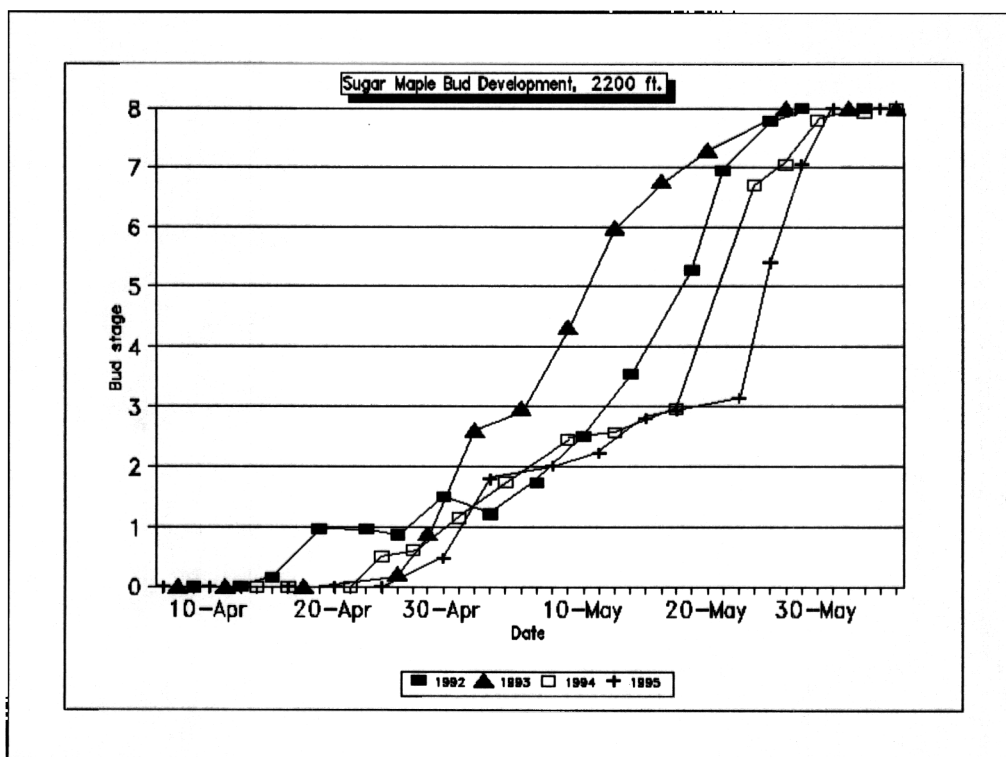
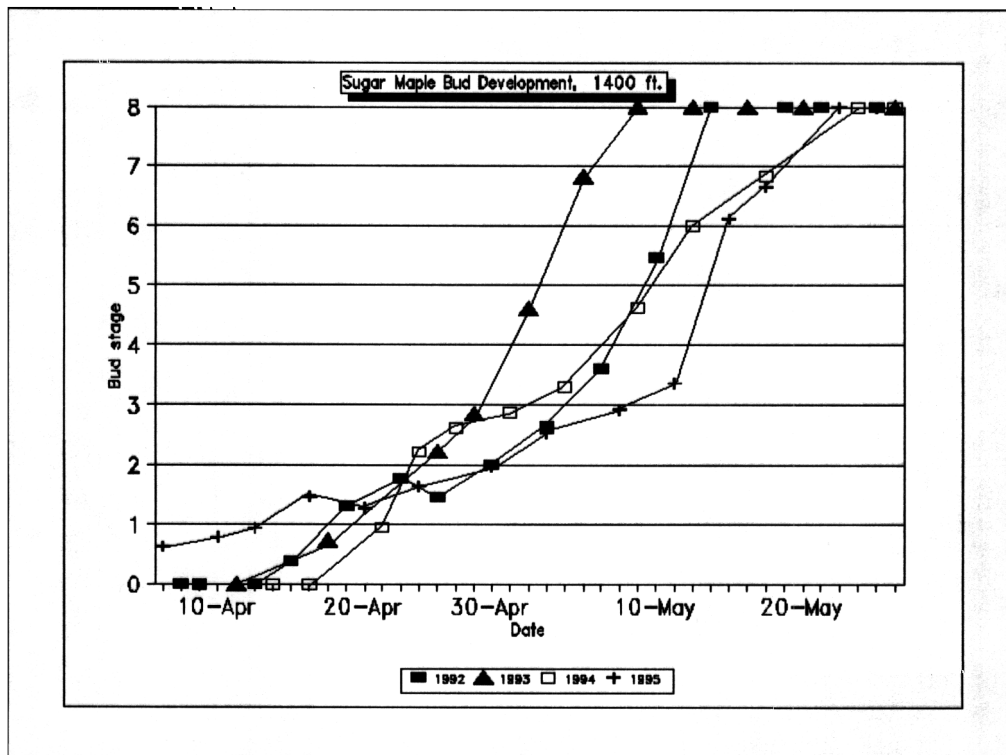
Sugar maple buds began swelling earlier than in past years. Development then slowed down, and budbreak was later than usual, 10 days later than in 1993 (Figure 1). Full leaf expansion was likewise later than other years, but similar to 1994 (late May). At the higher elevation site, early bud development was similar to other years, but slowed down at budbreak (late May) so that it was 2 weeks later than in 1993. The timing between budbreak and full leaf expansion was rapid and was completed in less than a week.

Beech buds at the 1400 foot elevation were slower in early stages of bud swell than in past years (Figure 2). Development mirrored 1994 from early budbreak through full leaf expansion, but was about 2 weeks later than in 1993. Average budbreak did not occur until May 19th, and full leaf expansion on June 2nd. At the 2200 foot elevation, average budbreak for beech trees was May 27th and full leaf expansion was June 4th. As with the lower elevation, development was slower and later than in most years, but very similar to development in 1994.

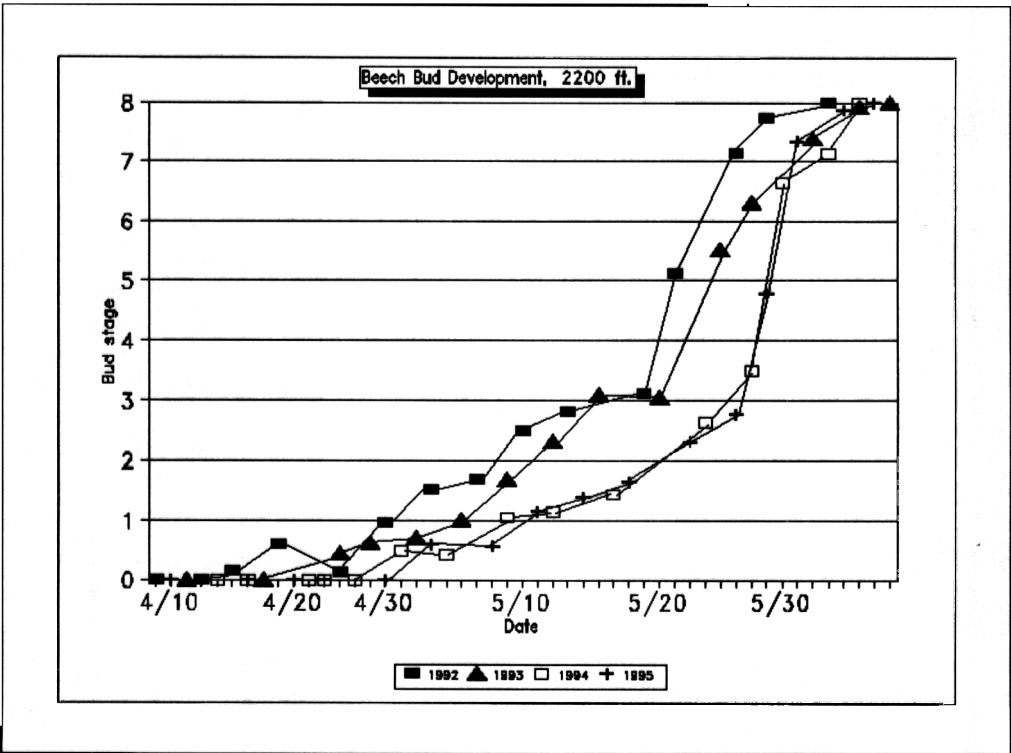
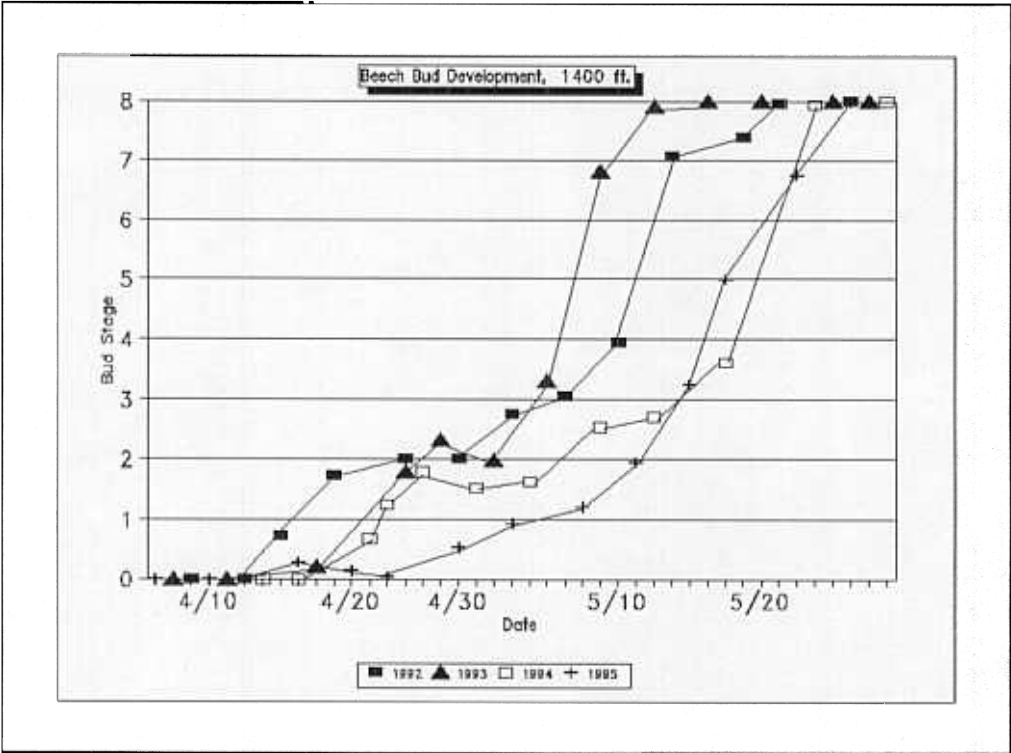
Yellow birch bud development began earlier than in the past three years, but proceeded at a pace similar to other years (Figure 3). Average budbreak occurred on May 12th and full leaf expansion on May 24th, slightly later than other years. Similar development occurred at the higher elevation site, with average budbreak on May 16th (as in 1994) and full leaf expansion on June 6th (similar to 1994). In general, development was slower than in 1993.

Comparisons between species at the 1400 foot elevation site reveals that red maple, sugar maple and yellow birch all reached budbreak together, on May 11 (Figure 4). Ash was the last species to reach budbreak, and this occurred on May 22. Full leaf expansion was reached first by sugar maple (May 15), followed by red maple and beech (May 22), yellow birch (May 25) and finally ash ( June 4).

**Figure 1.** Sugar maple bud development at 1400 and 2200 feet on Mount Mansfield from 1992-1995.



**Figure 2.** Beech bud development at 1400 and 2200 feet on Mount Mansfield from 1992-1995.



**Figure 3.** Yellow birch bud development at 1400 and 2200 feet on Mount Mansfield from 1992-1995.

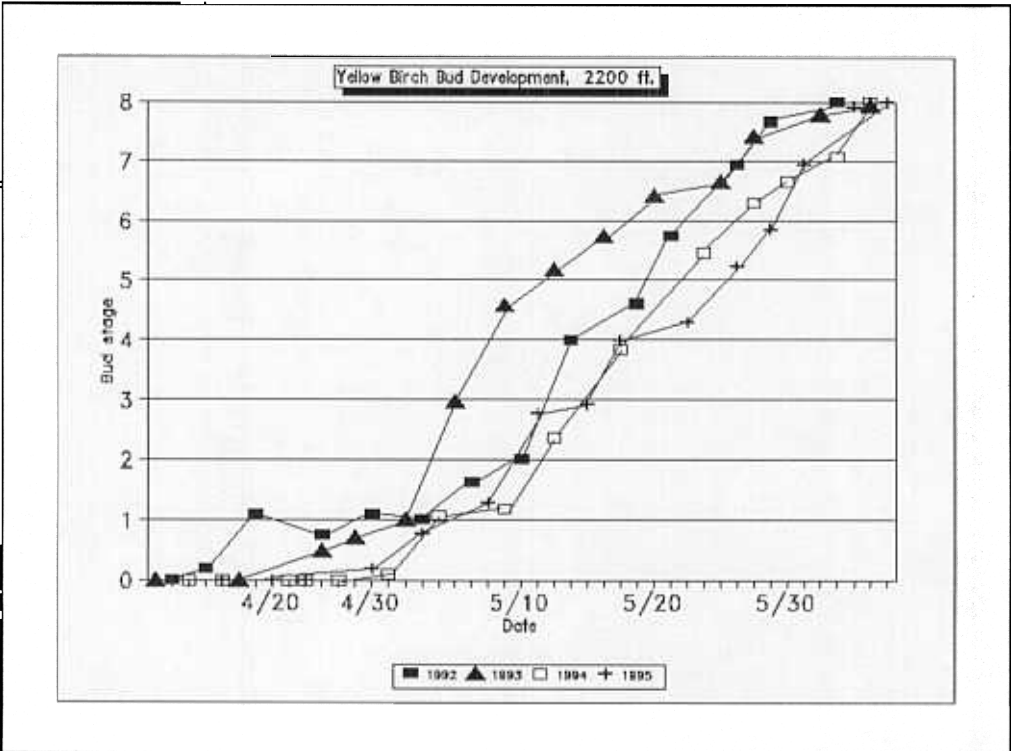
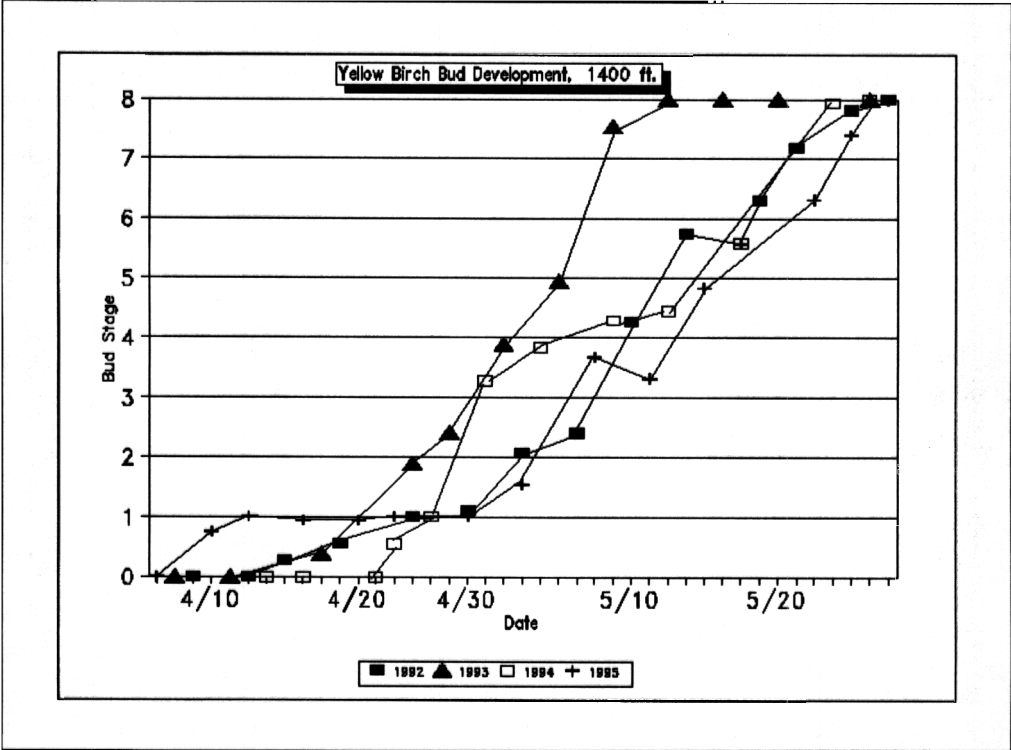
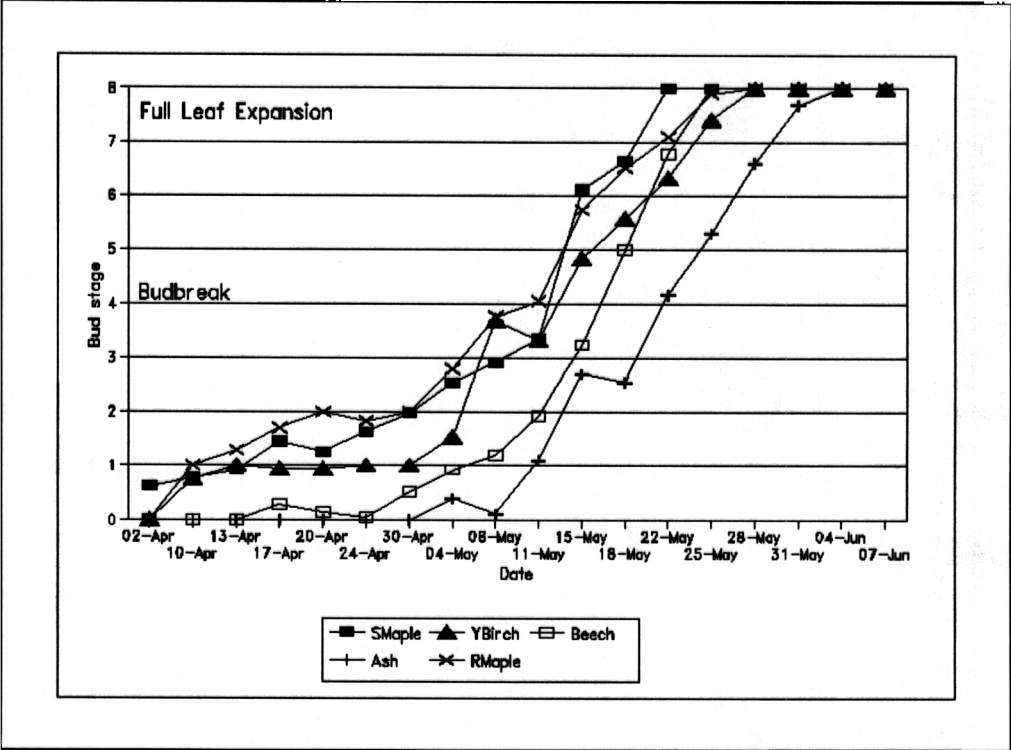




Figure 4. Bud development of species monitored at 1400' on Mount Mansfield in 1995.



## FALL COLOR AND LEAF DROP

The timing of fall color at the 2200 foot elevation was slightly earlier than in the past 3 years, while lower elevation color development was similar to past years.

Sugar maple color began later than previous years at the lower elevation site, but developed rapidly, so that full color (50% color with little leaf drop) occurred during the first week of October as usual (Figure 5). Color at the higher elevation is generally earlier than at 1400 feet, with full color occurring during the last 2 weeks of September. In 1995, full color occurred during the last week of September.

Beech color development began slightly later than past years at the lower elevation site, but mirrored other years in the timing of full color during the last week of September (Figure 6). Likewise, at the 2200 foot elevation, full color developed during the last week of September. The timing of beech color at this elevation has been variable over the years, spanning a 3 week period between the 3rd week of September and the 1st week of October.

Yellow birch fall color at the 1400 foot elevation was the earliest in the past 4 years of monitoring (Figure 7). Early color developed nearly 2 weeks ahead of 1993. The timing of full color was similar to other years, during early October. At the upper elevation site, the timing of yellow birch fall color was similar to other years, with full color occurring during the last week of September.

The timing and speed of leaf drop at the low elevation site was similar to past years, occurring during the 2nd and 3rd week of October (Figures 8-10). Leaf drop at the higher elevation tends to extend over a longer time period, and to be more variable between years. The majority of leaf drop at the 2200 foot elevation occurs between the 1st and 2nd weeks of October.

In 1995, leaf drop was similar to other years. The only exception was beech at 2200 feet, which showed significant leaf drop earlier than in past years.

Comparisons between species at the 1400 foot elevation site for 1995 shows that ash is the first of these species to reach full color and drop its leaves. Sugar maple is the last species to reach full color, and has significant leaf drop similar to red maple and yellow birch. (Figure 11).

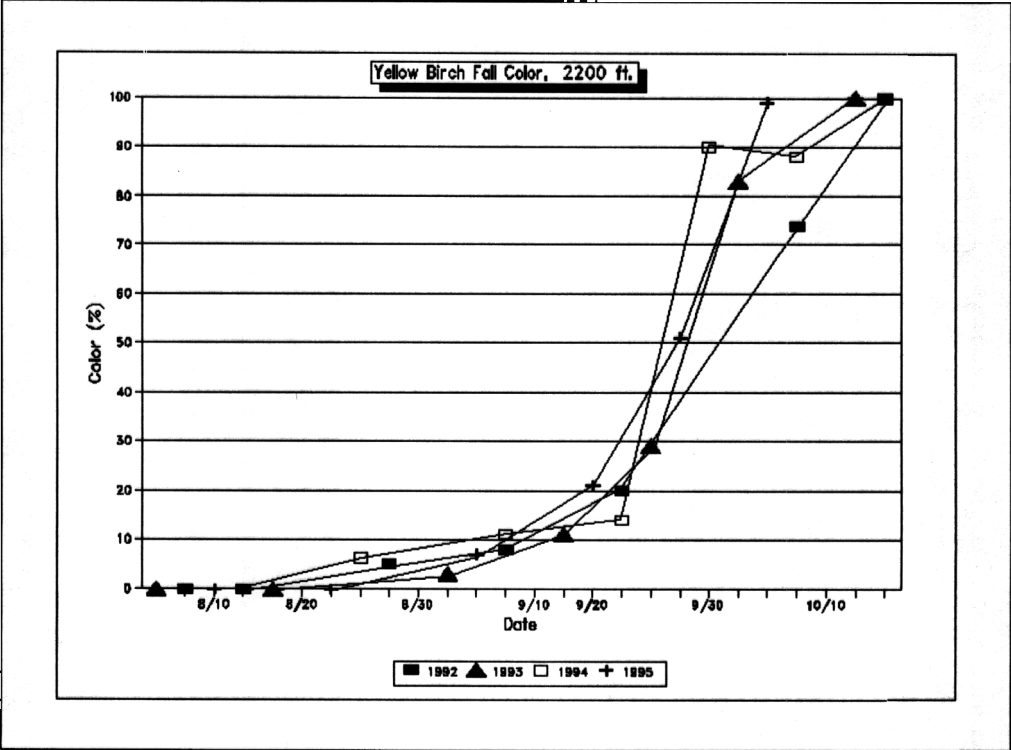
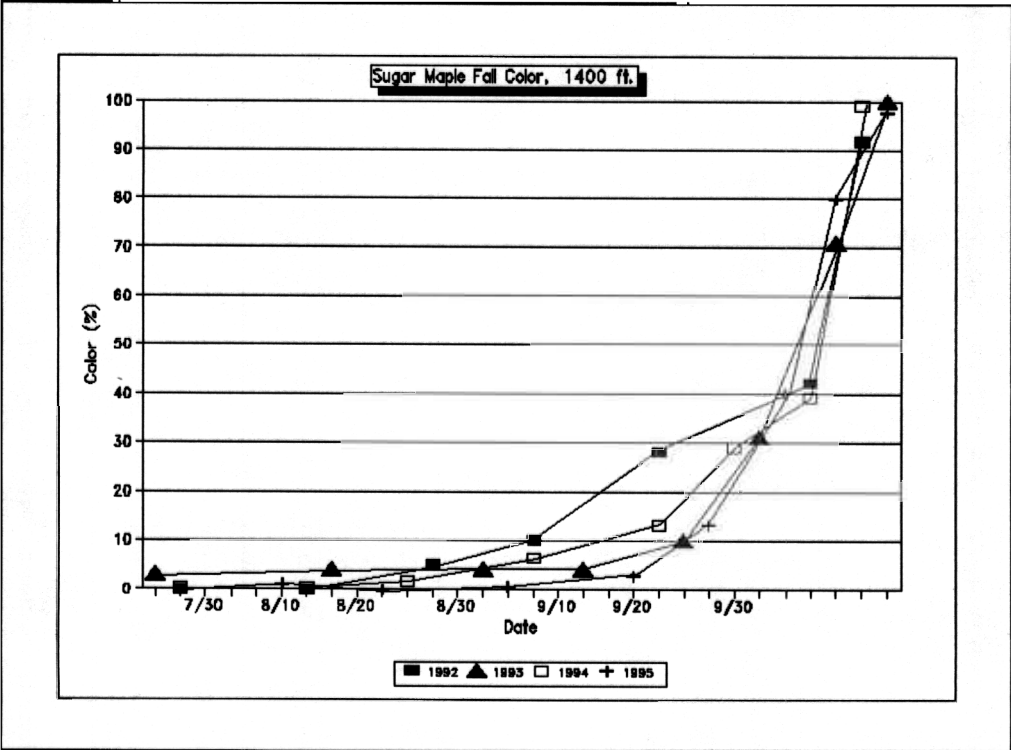
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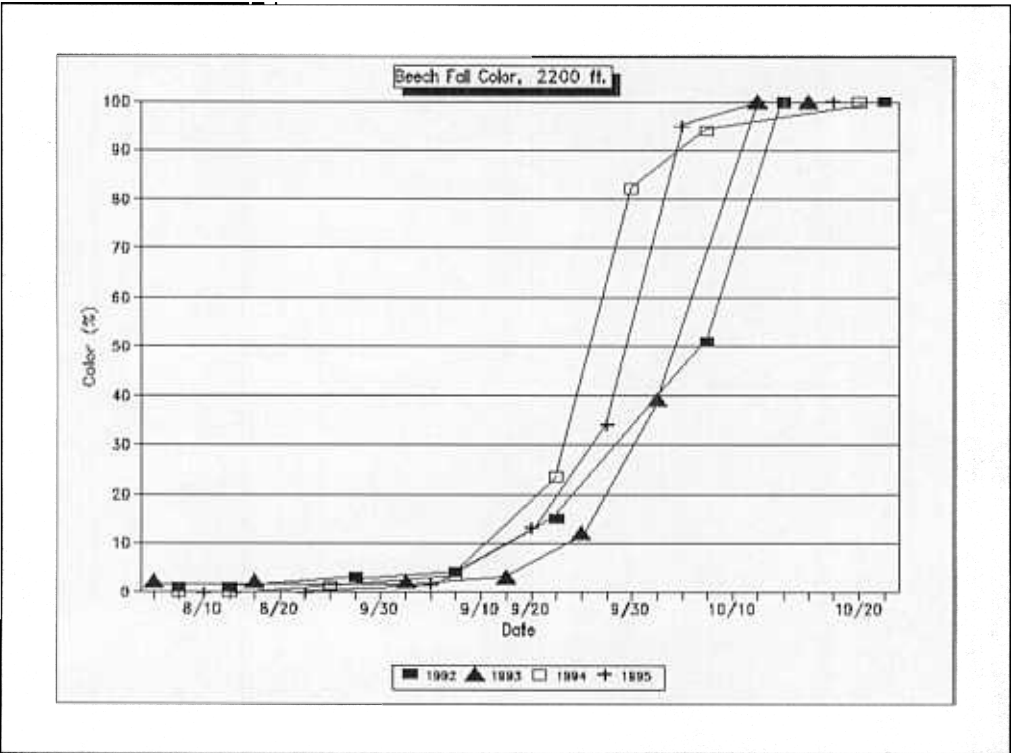
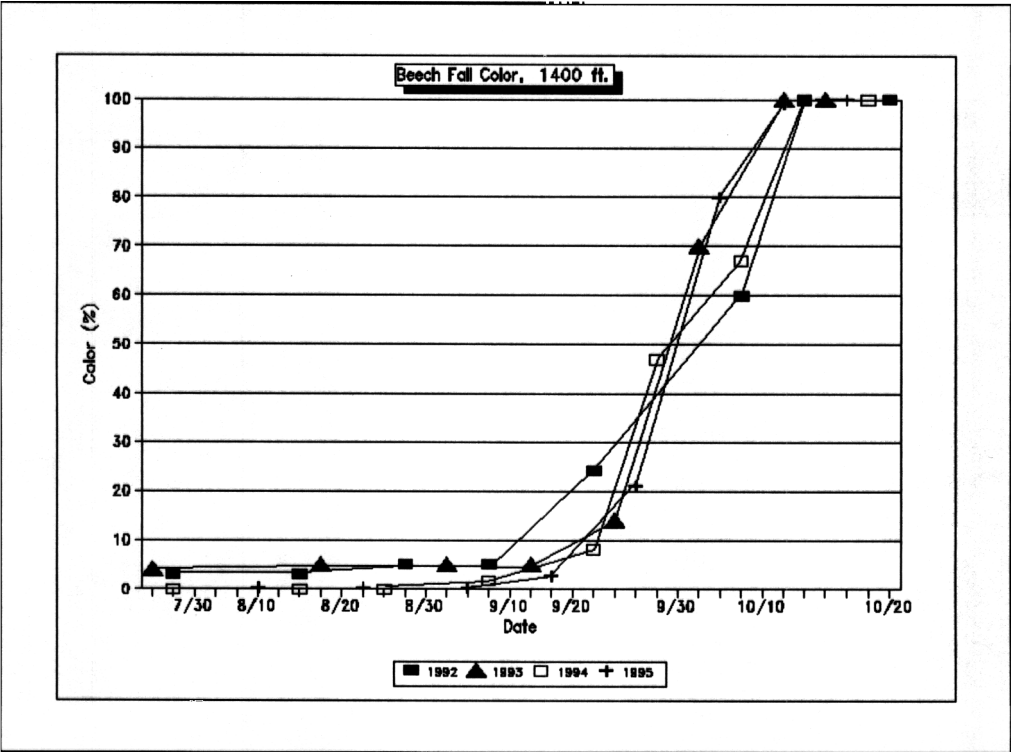
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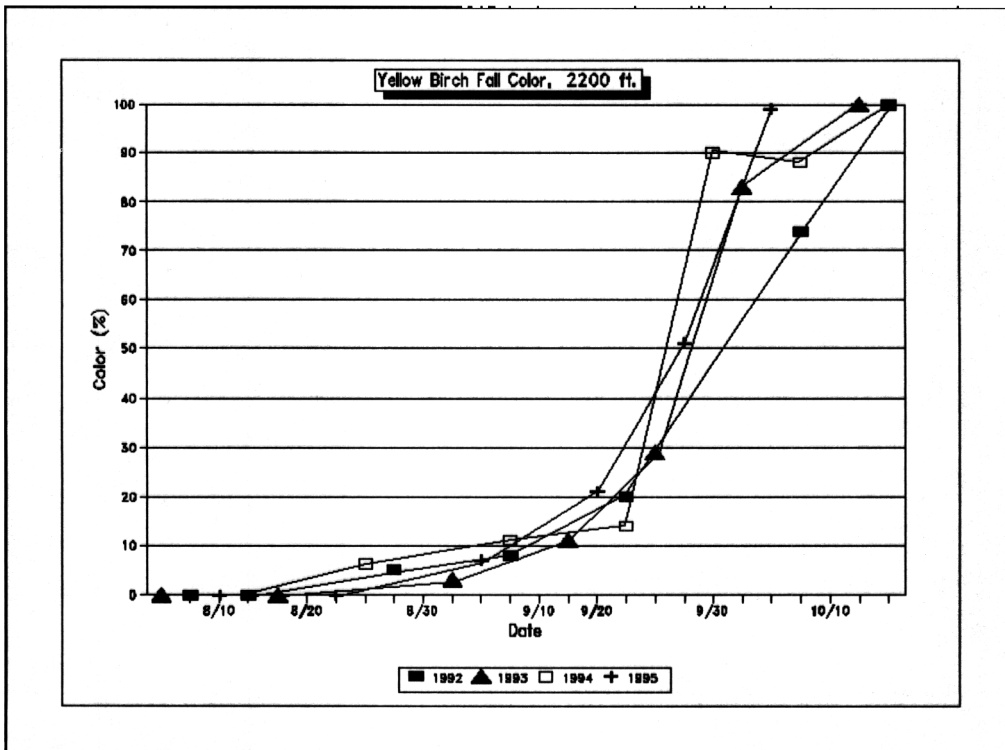
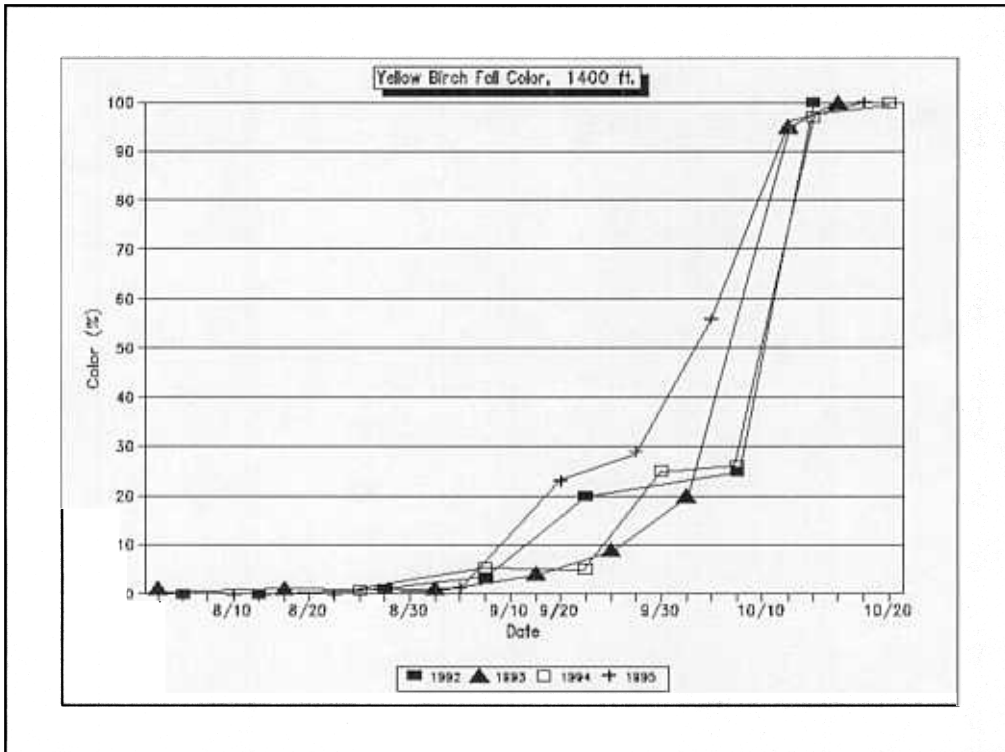
**Figure 5.** Timing of sugar maple fall color at 1400 and 2200 feet on Mount Mansfield from 1992-1995.



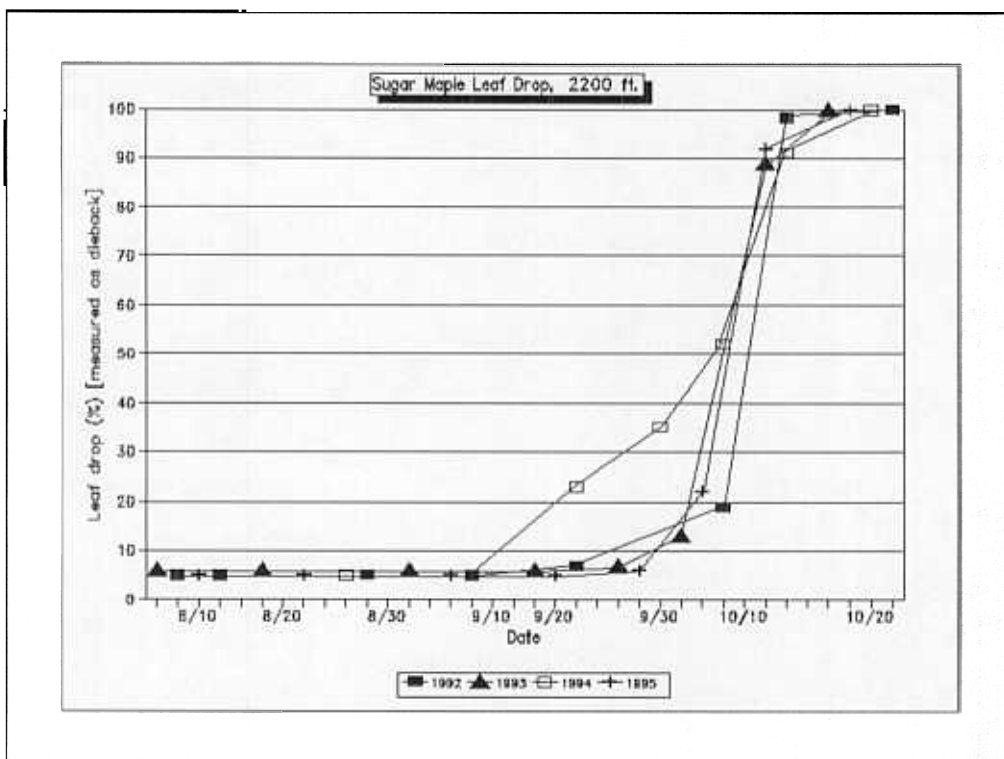
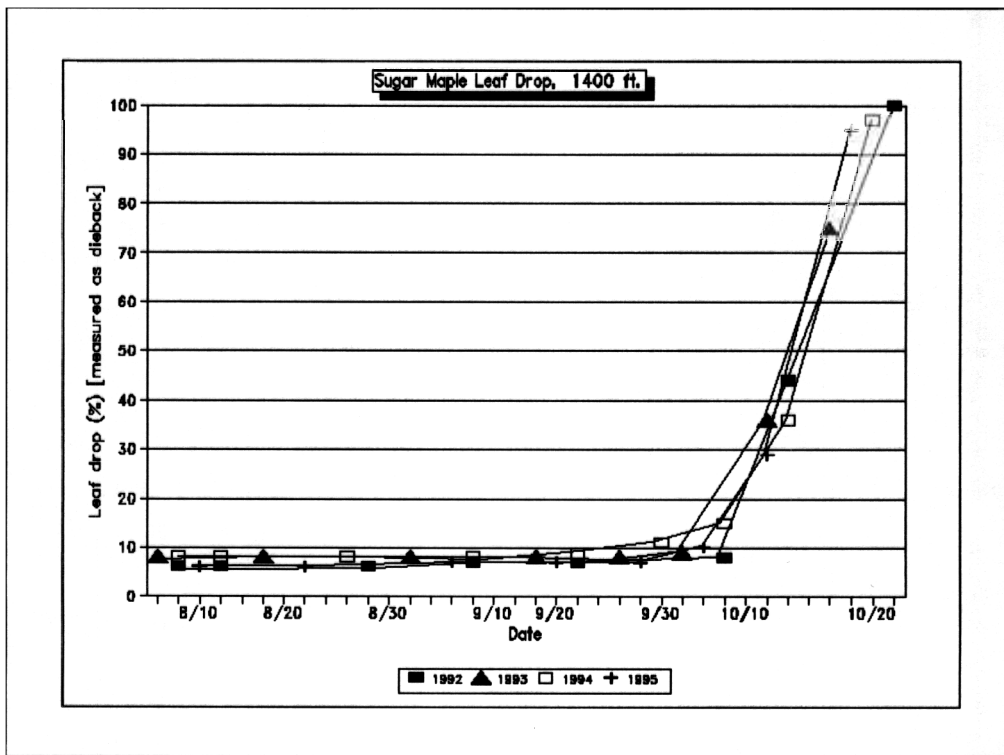
**Figure 6.** Timing of beech fall color at 1400 and 2200 feet on Mount Mansfield from 1992-1995.



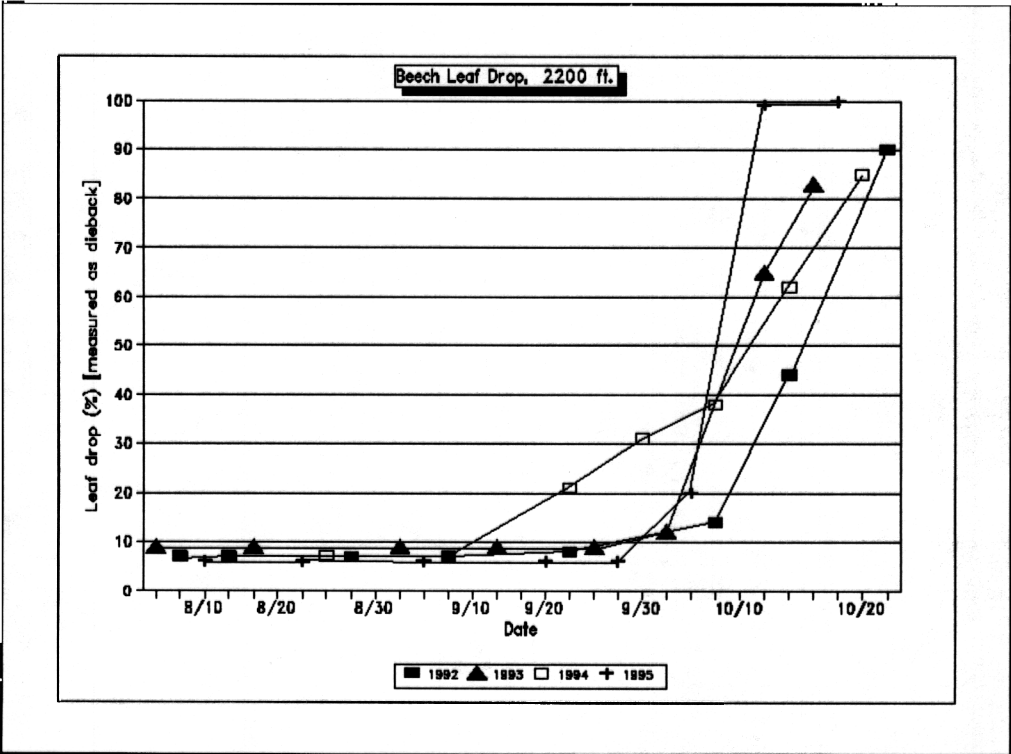
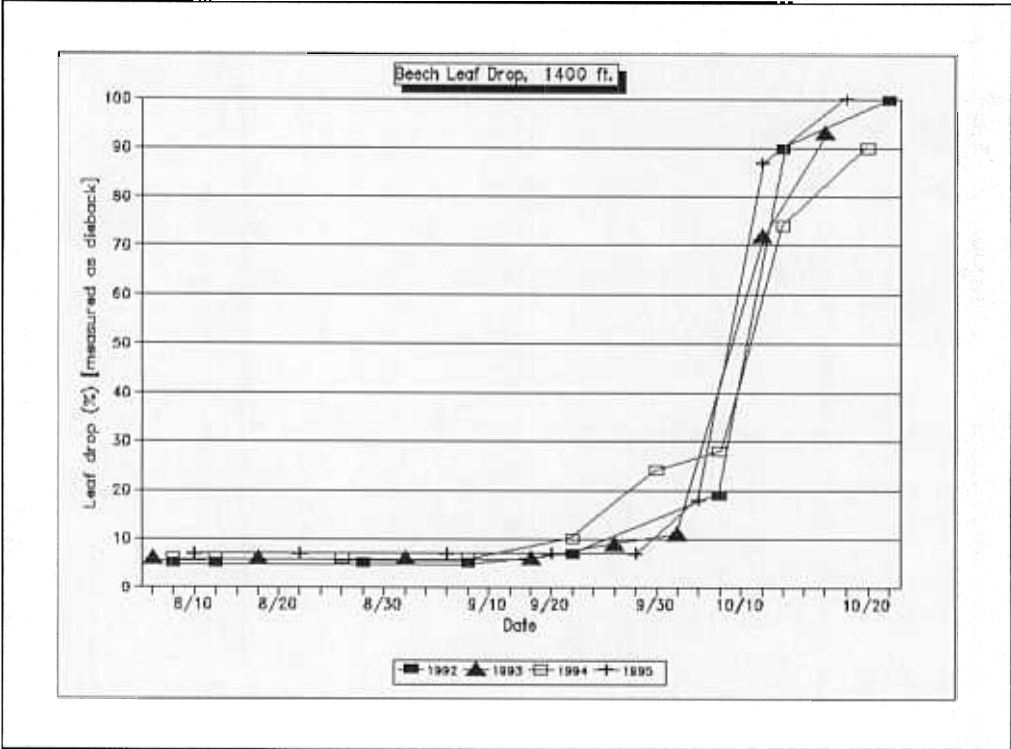
**Figure 7.** Timing of yellow birch fall color at 1400 and 2200 feet on Mount Mansfield from 1992-1995.



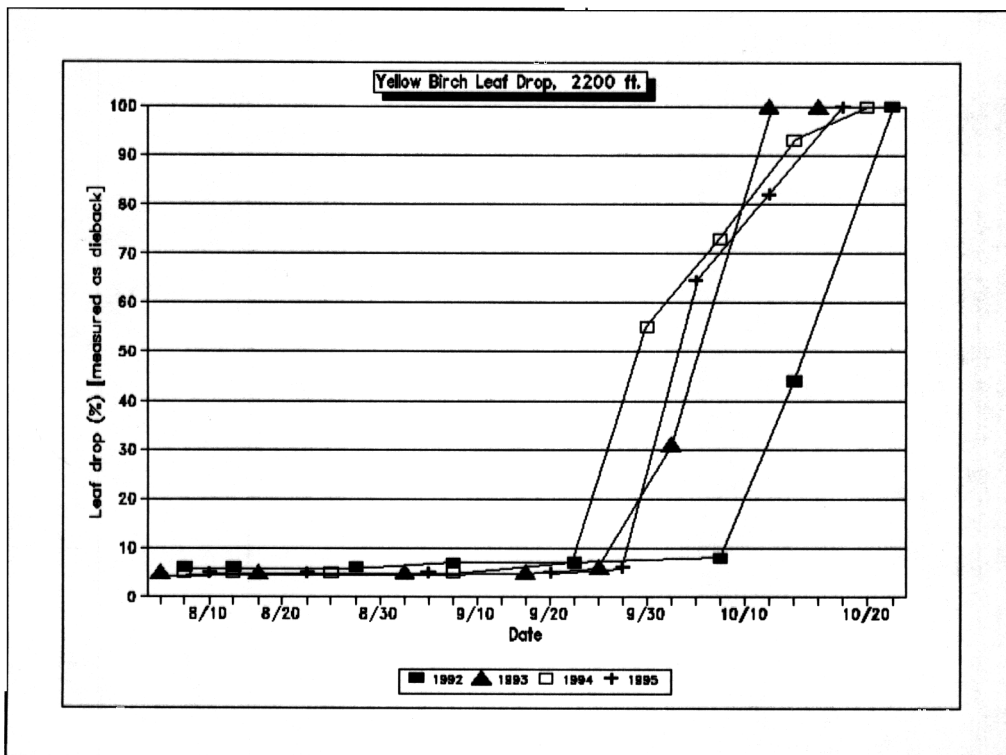
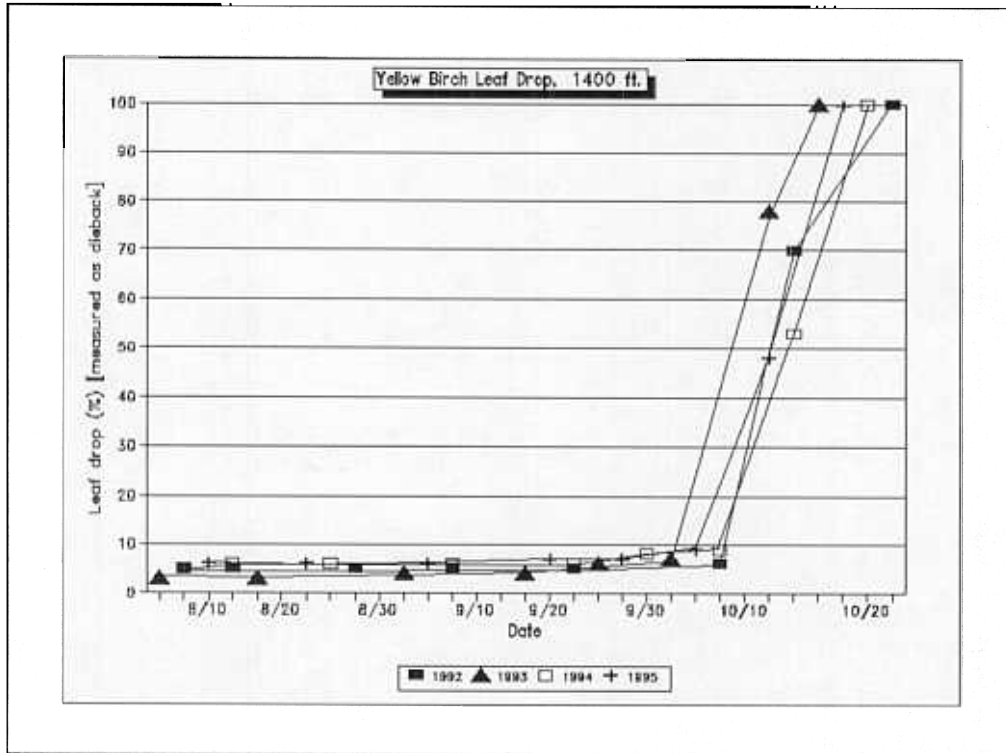
**Figure 8.** Timing of sugar maple leaf drop at 1400 and 2200 feet on Mount Mansfield from 1992-1995.



**Figure 9.** Timing of beech leaf drop at 1400 and 2200 feet on Mount Mansfield from 1992-1995.



**Figure 10.** Timing of yellow birch leaf drop at 1400 and 2200 feet on Mount Mansfield from 1992-1995.





**Figure 11.** Fall color and leaf drop of species monitored at 1400' on Mount Mansfield in 1995.

