Landscape fall color assessments and development of a monitoring protocol

Sandy Wilmot, Forest Health Specialist
Department of Forests, Parks and Recreation

Introduction

The timing, duration, and quality of fall color have been used for years as indicators of tree health on an individual tree basis. At the same time, these fall color elements are important to Vermont's tourist industry. Vermont foresters evaluate fall color each year and report their findings regularly to the Department of Travel and Marketing. Slightly different methods, terminology, and categories of color quality have been used by each individual making tree assessments. The purpose of this study, which began in 1997, was to compile information on techniques currently being used by foresters in fall foliage spotting for tourism and evaluations for forest health, and determine if a more systematic standardized approach could be developed.

Objectives

1. Compile information from County Foresters, Fall Foliage Spotters, and other professional foresters on techniques used to assess the timing, duration, and quality of fall color and leaf drop.
2. Develop a method for collecting data on the timing and duration of fall color and leaf drop to be used on forested landscapes for forest health assessments.
3. Make recommendations on a standardized method for data collection on the timing, duration and description of fall color for use by County Foresters and others who gather data annually on fall color for "viewing" purposes.

The methods and recommendations used for assessing fall color for "viewers" vs "forest health" are quite different, so will be examined separately.

Assessments for Fall Color Viewing

Methods:

Currently, each County Foresters working for the Department of Forests, Parks & Recreation is responsible for gathering information on fall color conditions in their area throughout the foliage season. This is done formally (i.e. repeatedly visiting certain key viewing spots or routes, or using a data sheet developed a number of years ago by the Travel Division), and informally (i.e. making observations during travels throughout the county). Information gathered is forwarded to the Department of Travel and Marketing twice weekly. Types of information that are valuable to this process include:

1. Where to find good foliage (i.e. certain routes, swamps vs hillsides, upper elevation vs lower elevation, etc).
2. Categories used to rate foliage viewing (i.e. early color, peak color, etc).
3. Descriptive words for color quality (i.e. brilliant, pastel, flashy, etc.).
4. Knowledge of factors that contribute to good fall color.
5. Range of dates for viewing that is specific for each area.

In October, 1997, a questionnaire was sent to each county to determine how these factors were being used by each forester, and to aid in developing standard methods for the future.

Survey Results:

Color Quality.

The quality of fall color can vary between years and between locations. All foliage spotters agreed that having brilliant colors was the most important factor for color quality (Table 1). The second most important factor, having to do with specific locations, was a contrast of tree species with good color. The third most important factor was to have good viewing weather (sunshine). Many of the respondents agreed that good color quality means greater than half the trees with color, and very little leaf drop.

Table 1. Results from a survey of "fall foliage spotters" on what they feel the most important factors in fall color quality are at a location or in a given year.

Most important factors in color quality at a location or in a given year.	Percent of respondents
Brilliant colors	100
Contrast of species with good color	85
Viewing weather is good	62
Greater than half the trees have turned color, and with very little leaf drop	54
Mix of color stages	46
Tree turn color all at the same time	46
Significant color lasts for longer than usual	31
Trees turn color at varying times	23

Definition of "peak color"

The definition used on the Foliage Spotter data forms defines peak color as: "brilliant, full color, 100%" (Table 2). Yet, there seems to be a wide range of opinions on what the definition should be. When asked if "peak" were based on a percent of the hillside with color, what should it be, the range was 50 to 100%. When asked if "peak" were based on a percent color and a percent leaf drop, what should it be, the range was even greater (40-100% color and 5-60% leaf drop). Most people felt that peak (or best viewing) should include some color, some green, and little leaf drop (Table 2).

Table 2. Foliage Spotter Data Form definitions of fall color stages.

Foliage Stage	Description	Percent color
Early	Color starting to appear	0-40%
Mid	Half-way to peak	40-60%
Near Peak	Almost full color	60-90%
Peak	Brilliant, full color	100%
Past peak	But still generally colorful	
Isolated color	Spotty conditions	

Table 3. Results from a survey of "fall foliage spotters" on how they would define the "Peak Color Stage".

Color range	Leaf drop range	Other Comments
70-100	5-30	Peak viewing should be based on a date for that area.
80-90	10	Peak viewing should be based on a date for that area, and be 5 days before and after that date.
50-60	10	Highest % of trees have changed color just before leaves start falling noticeably.
80	60	Some green is necessary; by the time green is gone, some trees have dropped leaves.
40-100	5-30	Color changes rapidly after you near 50%; if peak is 50%, color will last long enough for enjoyment.
50-100	Not important	When largest number of trees are at their most brilliant (even though some are still green and some have gone by).
70-100	5-40	Peak is when color is its best; the % varies from year to year.
90-100	5-20	Peak should refer to an expected percent color for that site, so requires an observer to know what to expect from different reference locations.
70	20	Peak is when all trees are brilliant, no browning, and no twigs are visible.
70	5-20	Peak foliage can be seen on individual trees long after the whole panorama has past peak.

Descriptive words for fall color

The survey asked foresters for words they use to describe fall color. Results are as follows:

"Brilliant, intense, awesome, bright, flashy, gorgeous, sharp, crisp, exceptional, radiant, on-fire, florescent, dramatic, superb, stunning, muted, dull, mottled, dark, light, pastel, gentle, spotty, pumpkin, russett, bronze, washed-out."

One respondent suggested that a plant tissue color chart could be used to standardize descriptions of colors statewide. This would facilitate description consistency between years.

Recommendations

For the purposes of fall foliage viewing, the two most important factors (data) needed to provide viewer satisfaction are: 1) routes or viewing locations where visitors can see high quality foliage, and 2)communicating this information to the Department of Travel and Marketing where the public can gain access to the information. The definitions and methods used by each individual vary greatly. Additional information on viewer satisfaction would be needed to determine which definitions and methods are most successful. Since all foliage spotters share the goal of providing information on where the best foliage can be viewed, it is possible to achieve statewide success without standardizing. If there is a need to standardize, a survey of foliage viewers would be needed to determine appropriate standards.

While this study was not successful in developing one standardized method for foliage spotters, the compilation of color descriptions, definitions of variables, and methods used for collecting data should provide a foundation for current and future foliage spotters to assess their individual techniques.

If, in conjunction with annual foliage reporting, foliage spotters are interested in collecting data to monitor differences between years at a given location, a method such as that for the forest health monitoring system should be implemented.

Forest Health Monitoring System

Individual tree monitoring of fall color and leaf drop on Mount Mansfield has been ongoing since 1990 as part of the Forestry Division's forest health monitoring efforts under the Vermont Monitoring Cooperative. While this monitoring effort has provided valuable information on tree stress effects on fall color, some landscape-level stress effects were not always captured on individual trees. This project attempts to complement existing individual tree monitoring by expanding it to a landscape-level, where addition species and site characteristics can be evaluated.

Methods

In selecting sites to use for forest health evaluations, the following factors were considered: 1. sites where hillsides or a large forested area can be viewed and photographed from easily accessible locations, 2. numerous sites (3-5) selected that represent a range of landscape characteristics (swamps, low elevation, high elevation) and forest types (northern hardwood, birch, etc), and 3. sites with predominantly hardwood trees (more than 85%). Other factors that were considered in site selection were: stand age, species composition, elevation span, aspect, drainage, and disturbance history.

Eight locations were selected on and around Mount Mansfield, representing a range of elevations and aspects (Table 5). Most viewing sites were roadside. Detailed descriptions of survey points were made to make it possible to view and photograph from the same locations each time. A tripod, level, and compass were used to repeat the viewing and photographing locations. The initial photos were used as a guide for viewing and photographing consistency.

The first year of monitoring determined the beginning and ending dates for future monitoring in each area. For monitoring at Mount Mansfield, monitoring was conducted from the end of August through October. Ratings and photographs were done weekly during the first year to establish color and leaf drop timing. Every other week ratings were used during the second year.

At each visit, the date, percent color, percent green, percent leaf drop, species changing color, color quality or brilliance, "foliage spotters description" and notes were recorded, and a photograph was taken. Color and leaf drop are visual ratings based on area affected, and recorded in 5% intervals (0=0, 5=1-5%, 10=6-10%, etc). Percent color is defined as the amount of forest foliage with color other than green. Percent green is the amount of forest foliage that is green. Leaf drop is based on branches without leaves (gray area), so is the amount of forest foliage dropped from trees. Percent color, green and leaf drop combined total 100. Percent color and leaf drop are added together in data analysis to reflect the area of a hillside that has changed color with or without leaf drop. Recording the species that are showing significant

color aids in identifying which species do or do not have brilliant colors for a given year. For forest health monitoring, these 4 measurements are the most critical.

Color quality is a totally subjective rating that attempts to capture color brilliance and beauty. A numeric rating is given, from 1 to 10, where 10 is a once in a life-time color scene. Factors contributing to quality rating include: a variety of colors, sharpness of crowns shape, lack of leaf drop, strong colors, and weather conditions at the time of viewing (sunny, cloudy, hazy). Besides allowing a comparison of fall color between years, this information helps to interpret the effects of wind, rain, snow or other environmental conditions on fall color and leaf drop.

A rating of "foliage spotters stages" was also recorded to learn how this system relates to the other measurements recorded (Table 2). Notes on color descriptions, stress agents involved in early color or leaf drop, and other assessments provided a valuable data supplement.

Special requirements were needed for photographs. Sunny, haze-free days were provided to secure the best photo representations of what was seen visually. Any low clouds shaded areas of the hillside making them too dark in photos. The sun also had to be high enough above the horizon to prevent photos being taken into the sun. As day length diminishes in October late day visits had to be avoided. When possible distinctive landscape features were used in the photographs to aid in replicating the same view (telephone poles, houses, fence posts).

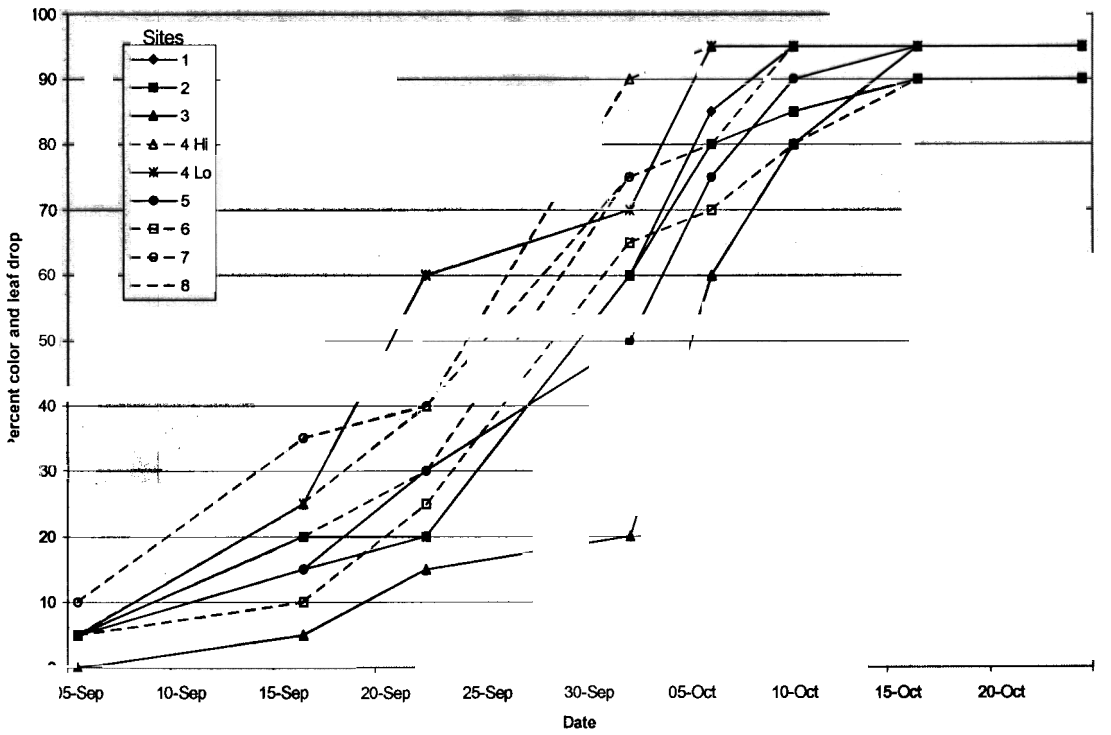
Table 5. Site descriptions of the eight landscape fall color monitoring locations on and around Mount Mansfield.

Site	Elevation range (ft)	Aspect	Forest Type	Predominant Species	Notes
	900 – 1800	East	Northern Hardwoods	Red maple, sugar maple, birch, aspen	
2	1100 - 1700	Northwest	Northern Hardwoods	Sugar maple, beech, birch, aspen	Recently logged
	1000 – 1500	Northeast	Hardwoods	Beech, birch, poplar	
4	1000 – 3000	West	Mixed: high elevation yellow birch, low elevation hardwood	Yellow birch; red maple	mid-elevation recently logged
5	1000 – 1800	South	Northern Hardwoods	Maples	
6	1100 – 1500	Southwest	Northern Hardwoods		
	100 – 2500	Southwest	Northern Hardwoods	Sugar maple	
8	100	East	Northern Hardwoods	Red maple, sugar maple, poplar	

Results

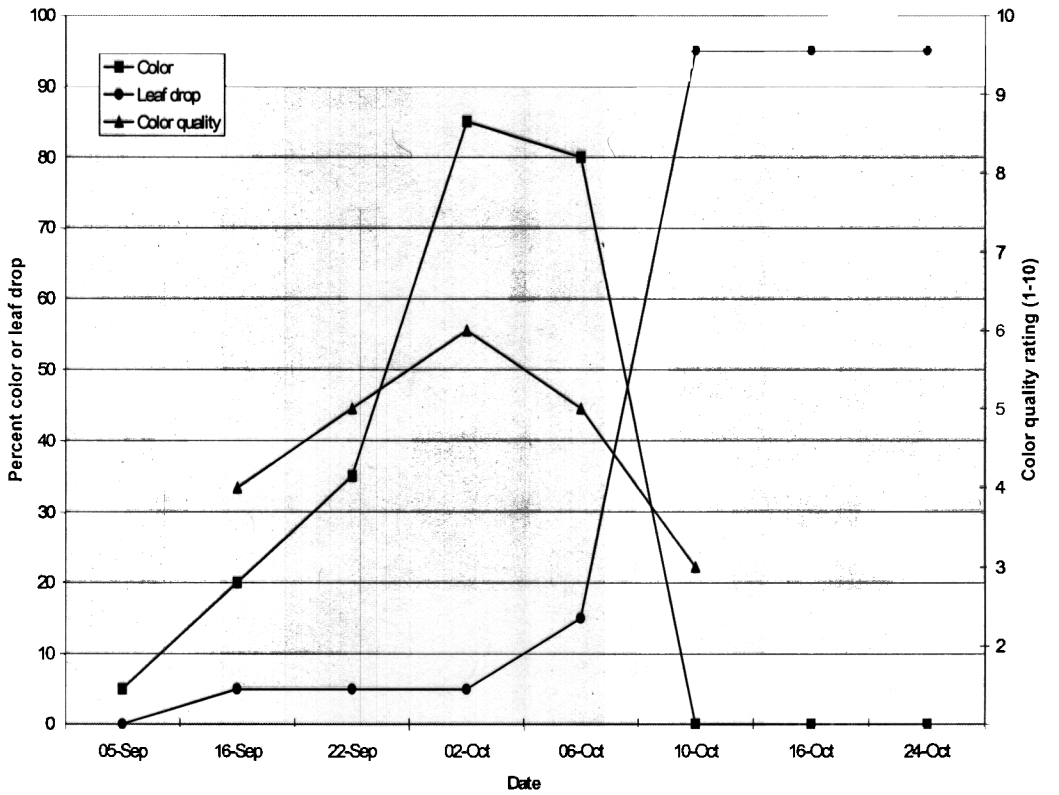
Variation between sites. The timing of leaf color and drop varied greatly between the eight sites monitored (Figure 1). The two extremes were Sites 3 & 4. In early October 1997, Site 4 had 90% color and leaf drop, while Site 3 had only 20%. The sites selected represent the range of elevations found in the Green Mountain Biophysical Region: high elevation sites (Sites 4 & 7), and low-to-average elevations (Sites 1, 2, 3, 5, 6, & 8). These sites do not include red maple swamps, oak forests, as well as other unique landscape-forest type situations, but they do represent many of the forested conditions typical of this biophysical region. While more data are needed to establish a baseline of "normal" fall color timing and duration, the absence of significant stress in 1997 could be interpreted as what should occur during normal years.

Figure 1. Fall color and leaf drop ratings from 8 sites on and around Mount Mansfield for 1997. There is a wide range in the timing of color and leaf drop between sites.



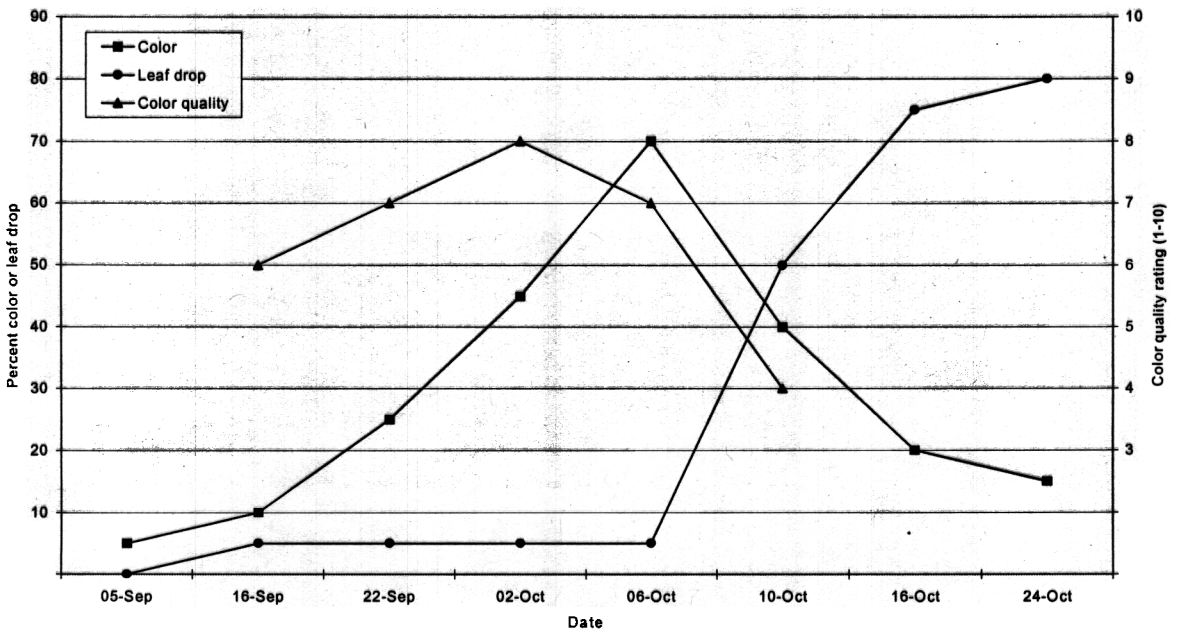
Comparison of measurements. Each of the measurements: fall color, leaf drop and color quality; can provide valuable information on the impact of stress events on tree health. Early color is common on individual stressed trees (e.g. tree decline from beech bark disease, drought impacts). In extreme stress situations, leaf drop can be premature. And color quality can be affected by significant insect defoliation, browning from leaf diseases or scorched leaves, as well as from weather events during fall color season (e.g. frost). The interpretation of results for each year should vary depending on current and past stress events, site conditions, and species. For 1997, growing conditions were favorable to tree health, so few trees had early color or leaf drop. A long gradual fall color season where color improved but leaf drop was delayed produced one of the best viewing seasons in recent history (according to veteran fall foliage spotters) (Figure 2). Using one site (Site 4) as an example of the interaction of measurements, peak color quality occurred on October 2nd, with nearly 85% of the hillside with fall color and 5% leaf drop. There was a slight decrease in color quality on October 6th, as leaf drop increased to 15%. By October 10th, full leaf drop had occurred, and with it, tree dormancy for the year.

Figure 2. Fall color, leaf drop and color quality measurements for one site on Mount Mansfield (Site 4) in 1997. Color quality was at its peak on October 2nd when nearly 85% of the hillside had fall color, and less than 5% of leaves had dropped.



Relationship between color and weather. Seasonal weather also plays a role in the timing and duration of color and leaf drop, as well as color quality. In 1997 at Site 5, color and color quality advanced to October 2nd (Figure 3). Between October 2nd and 6th, a snow storm coating foliage reduced the brilliance of color quality, but did not affect leaf drop. Between October 6th and 10th, a wind event triggered significant leaf drop.

Figure 3. Fall color, leaf drop and color quality measurements for one site on Mount Mansfield (Site 5) in 1997. Color quality was affected by early season snow accumulation between October 2nd and October 6th that reduced foliage brilliance, but did not affect leaf drop.



Comparison between years. The Mount Mansfield area data shows that fall color began earlier in 1998 than in 1997 (Figures 4 and 5). During the third and fourth weeks of September, significant color was observed in 1998, while only early color was observed during the same time period in 1997. Early fall color can be an indication of tree stress. The spring of 1998 was dry, followed by an over-abundance of precipitation during the summer months, creating a favorable environment for many leaf diseases. These two factors may have contributed to stress-induced early coloring. However, with two years of monitoring data it is premature to make conclusions about one year being early or late.

Many foliage spotters reported better than usual fall colors in 1997. While the "color quality ratings' for 1997 and 1998 are similar (indicating the difficulty and subjective nature of the rating), the viewing period was longer in 1997 because leaf drop was nearly a week later than in 1998.

Figure 4. Comparison of 1997 and 1998 fall color and leaf drop combined for all 8 sites monitored at Mount Mansfield.

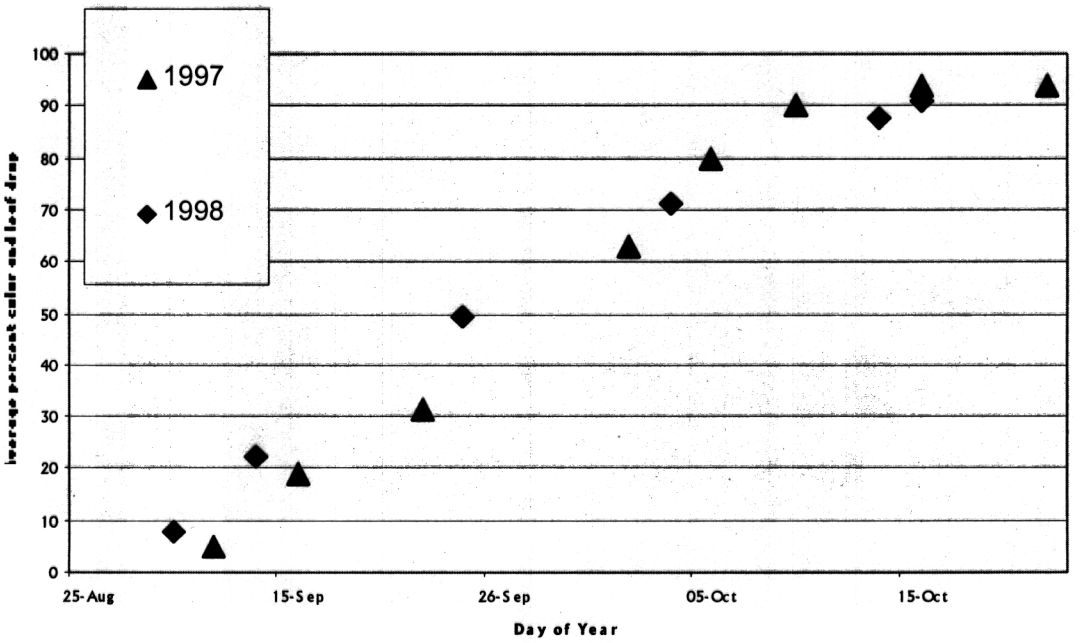
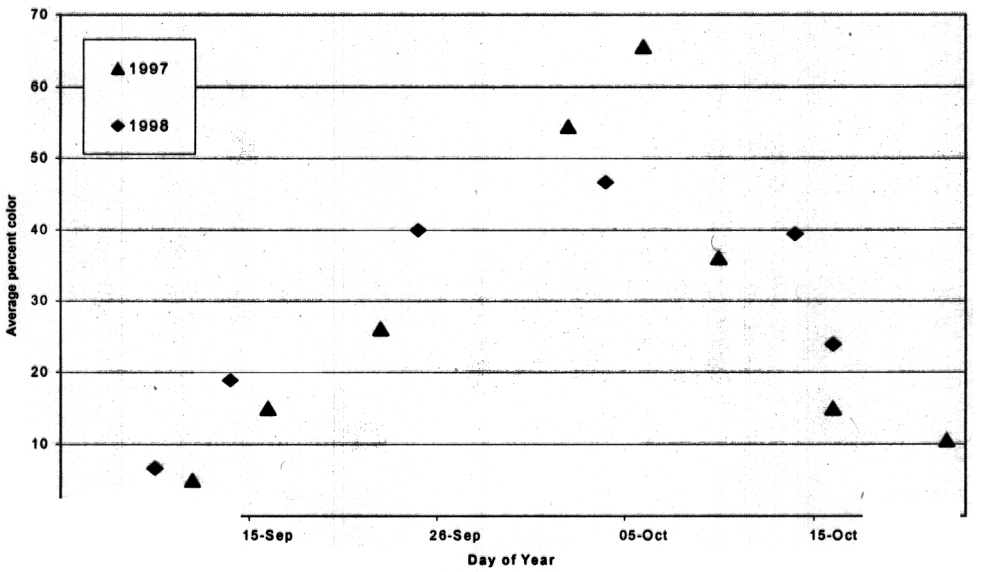


Figure 5. Comparison of 1997 and 1998 fall color for all 8 sites monitored at Mount Mansfield.



Discussion

The most difficult part of this monitoring technique is the choice of locations to monitor. The interpretation of results will depend on site characteristics (wet or dry, high of low elevation, etc) and tree species composition. The locations chosen at Mount Mansfield seem to capture a wide range of site characteristics representative of this biophysical region. Two years of using the methods described here has illustrated differences between years in how stress events affect fall color and leaf drop. This visual procedure is difficult, but was aided by past work rating individual trees for fall color. Remeasurement of these data in 1998 by an independent rater showed that the measurements of color and leaf drop were consistently within

0-10% at each site. The color quality rating was more difficult to reliably repeat, but seems valuable especially where stress agents can influence fall color in ways other than timing and duration.

The advantage of this monitoring system compared to current foliage spotter's techniques is that the same locations are used throughout the season and between years, providing data to support observational information. Due to the limited geographic spread of this method, however, it will not satisfy many of the needs for fall foliage spotter information.

Plans for the future include more extensive characterization of each of the sites (soil depth, slope, tree species composition and age, etc), investigation into computer software packages that could calculate color and leaf drop, and further testing of these methods by other foresters in a statewide pilot project.