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SUMMER MOISTURE CONTENT OF SOME NORTHERN LOWER MICHIGAN UNDERSTORY PLANTS

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ABSTRACT.—Summer moisture contents and factors for converting fresh plant weights to ovendry weights were determined for selected herbs, ferns, and small shrubs commonly found on upland sites in northern Lower Michigan. Sampling was done weekly from mid-June through early September 1978, following the period of major plant growth. Average summer moisture contents ranged from 120 percent for blueberry (*Vaccinium* spp.) to 370 percent for wild lily-of-the-valley (*Maianthemum canadense*). Generally, moisture content decreased through the summer. Moisture content averages and trends were similar for plant groups sampled in both northern Lower Michigan and northeastern Minnesota. Herbaceous fuel moisture percentages computed using the 1978 National Fire Danger Rating System for the same time period showed a similar general trend but were significantly lower than observed values.

KEY WORDS: forest fuels, fuel modeling, plant biomass, fire danger.

The moisture content of shrubs, ferns, and herbaceous plants can greatly influence wildland fire behavior. In fact, live fuel moisture input is required for predicting fire behavior (Rothermel 1972, Albini 1976, Deeming *et al.* 1977). Moisture content information is also used to compute factors for converting field green weights to dry weights, which are used to determine forest fuels, range forage, wildlife foods, or simply biomass.

Estimating both herbaceous and woody live fuel moisture is part of the National Fire Danger Rating System—NFDRS (Deeming *et al.* 1977, Burgan 1979). However, Loomis *et al.* (1979) found that estimates produced by the NFDRS algorithm for predicting herbaceous live fuel moistures were significantly lower than observed field measurements of live fuel moisture. This suggested a need for further study of live fuel moisture contents under other eastern forest stands.

This paper reports on live fuel moisture contents found in northern Lower Michigan and compares them to live fuel moisture contents measured in Minnesota (Loomis *et al.* 1979). Live fuel moisture estimates based on the NFDRS are also examined.

METHODS

Above-ground parts of living herbs, ferns, and small shrubs were collected weekly in Roscommon County, Michigan. Eight plant species or species groups were studied. Samples were collected from within a forest stand or from small openings. The two principal overstory species were jack pine (*Pinus banksiana* Lamb.) and northern pin oak (*Quercus ellipsoidalis* Hill). The stands were approximately 50 years old. Soils were predominantly sandy. The first samples were collected on June 13 and the last on September 6, 1978.

Ten 5-gram samples of fresh material were collected per plant group. These were sealed in metal cans, transported to the laboratory, and ovendried at 105°C for at least 16 hours. An average moisture content (expressed as percent of ovendry weight) for each plant group was determined. In addition, factors for converting green weights to ovendry weights were computed (conversion factor = ovendry weight ÷ green weight).

The time series of weekly moisture contents were examined and compared on the basis of magnitude, seasonal trend, and location. Graphical analysis, multiple comparisons, t-tests, covariance analysis, and regression analysis were the principal analytical methods used. The NFDRS live fuel moistures were computed using weather data for the Houghton Lake Airport, which is located about 10 miles from the data collection area.

RESULTS AND DISCUSSION

Average seasonal moisture contents ranged from 370 percent for wild lily-of-the-valley (*Maianthemum canadense*) to 120 percent for blueberry (*Vaccinium* spp.) (table 1). Moisture contents decreased during the summer sampling period. Therefore, we stratified the data into "early" (June 13 to July 24) and "late" (July 25 to September 6) season and computed separate averages for each.

Species differences were examined with a multiple comparison plot. Most of the plant group responses were different, but means of certain plant group combinations were not significantly different. Linear regressions of changes in moisture content yielded significant relations for all species groups except grass[1] (table 2). All regressions, including that for grass, represented expected response.

A multiple comparison plot was made for six of the eight plant groups studied in Michigan that were also studied in Minnesota during the summer of 1976 (fig. 1). Eight of 11 pairs tested were not significantly different. Moisture contents for Minnesota wild lily-of-the-valley (late), large-leaved aster (early), and

[1]*Covariance analysis supported these combinations.*

Table 1.—*Moisture contents, standard errors, and conversion factors for some grasses, forbs, and small shrubs in northern Lower Michigan*

Plant group	All (June 13 to Sept. 6)			Early (June 13 to July 24)			Late (July 25 to Sept. 6)		
	Moisture content[1]	Standard error	Conversion[2] factor	Moisture content[1]	Standard error	Conversion[2] factor	Moisture content[1]	Standard error	Conversion[2] factor
	Percent			*Percent*			*Percent*		
Wild lily-of-the-valley (*Maianthemum canadensis*)[3]	370	15	0.21	403	18	0.20	331	10	0.23
Large-leaved aster (*Aster macrophyllus*)[3]	349	15	.22	369	27	.21	328	5	.23
Bracken fern (*Pteridium aquilinum*)[3]	258	17	.28	287	31	.26	229	7	.30
Grass[4]	200	15	.33	219	25	.31	180	14	.36
Rubus (*Rubus spp.*)[3]	167	9	.37	194	10	.34	141	4	.41
Sedge (upland) (*Carex spp.*)[3]	146	23	.41	163	8	.38	129	4	.44
Sweet fern (*Myrica asplenifolia*)	124	6	.45	140	7	.42	108	2	.48
Blueberry (*Vaccinium spp.*)[3]	120	5	.45	134	16	.43	105	2	.49

[1]Moisture content percent = (100 × moisture content ÷ ovendry weight).
[2]Conversion factor = ovendry weight ÷ green weight.
[3]Used for the comparison with data from Minnesota.
[4]Includes *Adropogon gerardi, Schizachyrium scoparium, Agropyron caninum.*

Table 2.—*Equations for predicting summer moisture contents of certain living plant groups in northern Lower Michigan: where Y = moisture content percentage, X = number of days since June 12*

Plant group	Equation	r^2	Sy·x
Wild lily-of-the-valley and Large-leaved aster	Y = 430.39–1.76X	0.38	60.
Bracken fern	Y = 320.97–1.47X	.48	46.
Grass	Y = 244.49–1.03X	.32	45.
Rubus spp.	Y = 215.30–1.11X	.94	9.
Carex spp.	Y = 176.37–0.70X	.75	12.
Sweet fern and blueberry	Y = 147.97–0.60X	.76	10.

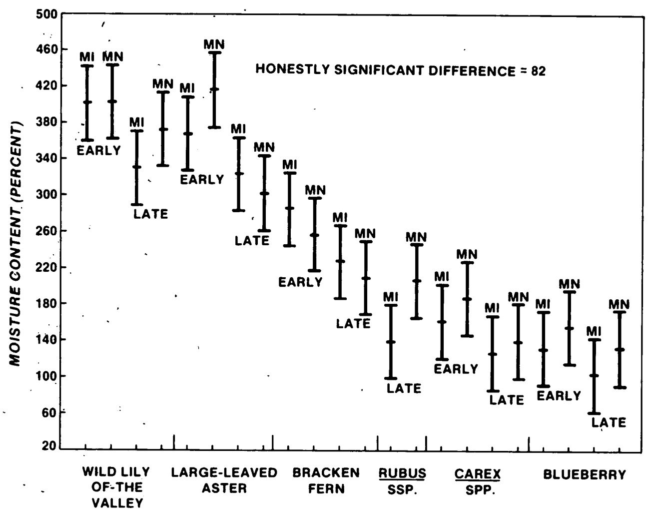

Figure 1.—*Multiple comparison of Minnesota and Michigan summer living plant moisture contents using Tukey's honestly significant differences. (HSD)*

Rubus (late) were significantly higher than those for Michigan.

The NFDRS-computed herbaceous and woody live fuel moistures for climate class 3 were calculated for the sampling period.[2] Weekly mean NFDRS moisture contents were compared to the weekly moisture contents of *Carex* spp. (low moisture content), bracken fern (medium moisture content), and large-leaved aster (high moisture content) (fig. 2). No inventory was available for determining an average

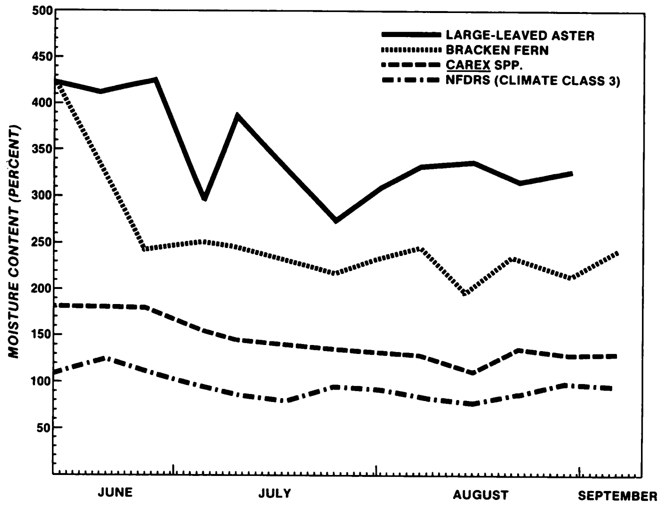

Figure 2.—*A comparison of National Fire Danger Rating System (NFDRS) climate class 3 herbaceous fuel moistures and some actual herbaceous moisture contents in Roscommon County, Michigan, 1978.*

herbaceous fuel moisture for Michigan as was done in the 1976 Minnesota study. However, it is obvious that the composite herbaceous fuel moisture content of any particular area can vary greatly depending upon numbers of various plant species. All herbaceous species we studied had moisture contents exceeding the NFDRS estimates, similar to results in Minnesota. Thus, use of the NFDRS herbaceous fuel moistures is not acceptable when absolute fuel moisture estimates are needed.

The overall summer weather was similar for Michigan in 1978 and Minnesota in 1976 in that it was unusually dry. Thus, the plants at both locations were subjected to above average moisture stress. Samples at both locations were taken shortly after mid-day when plants would most likely be having difficulty maintaining full tugor pressure.

The moisture contents of blueberry and Rubus, which are common small woody plants, were compared with NFDRS woody fuel moisture (fig. 3). Both had statistically significant decreasing moisture trends through the season. In contrast, the NFDRS woody fuel moisture shows an increasing trend. Therefore, actual measurements again are best when absolute fuel moisture estimates are required.

[2] *Climate class 3 was used because it is recommended for use throughout most of the eastern forest area.*

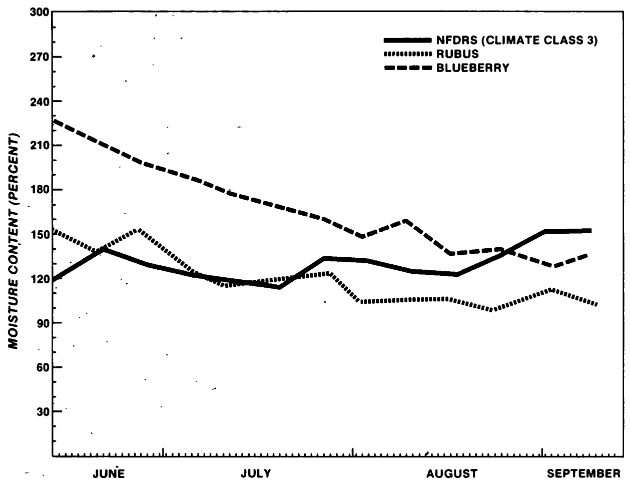

Figure 3.—*A comparison of National Fire Danger Rating System (NFDRS) climate class 3 woody fuel moistures and some actual small woody plant moisture contents in Roscommon County, Michigan, 1978.*

CONCLUSIONS

The NFDRS algorithms may be used to compute herbaceous and woody fuel moistures to estimate relative fire behavior trends for a season. However, they should not be used when absolute values are required because they are subject to error, particularly for herbaceous fuel moistures. The average moisture content values reported here are appropriate when general estimates are needed for planning over broad areas and for large trends in Lake States northern forests. The conversion factors are suitable for dry weight determination when approximate estimates are sufficiently accurate. These results further suggest that moisture response characteristics of similar plant species may be nearly uniform throughout the Lake States northern forest.

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