

## FIRE AND LANDSCAPE DYNAMICS IN YELLOWSTONE NATIONAL PARK

William H. Romme  
Department of Biology  
Fort Lewis College  
Durango, CO

Don G. Despain  
Research Office  
Yellowstone National Park  
Yellowstone Park, WY

### Objectives

This study is an investigation of long-term patch dynamics in the mosaic of forest communities covering the subalpine plateaus of Yellowstone National Park. The study is being supported by the National Science Foundation (Grant No. BSR - 8408181). Our specific objectives were summarized in the 1985 Annual Report.

In 1986 we continued the work described above, and also carried out an investigation of forest encroachment into subalpine meadows in Yellowstone Park (Patten 1969). This meadow project fits into the overall objectives of the study because (1) the meadows are an important element in the landscape diversity of this area, and (2) we had encountered some difficulty earlier in distinguishing between young forests of fire origin and forests that had invaded meadows in the absence of fire. Our investigation of forest encroachment involved (i) identification of criteria for recognizing forest encroachment into meadows in the absence of fire, and (ii) an analysis of macro-climatic factors that may be correlated with tree establishment in meadows.

### Methods

Our methods for reconstructing fire history and past landscape mosaics were summarized in the 1985 Annual Report.

For the meadow study, we made a detailed investigation of four meadows on the Central Plateau that showed evidence of recent forest encroachment. We first attempted to document the sites where trees had invaded former meadow areas by examining phytoliths (plant opal) in the soil and measuring soil pH along a transect from the open meadow into an adjacent forest of known fire origin (Miles and Singleton 1975), but these results were inconclusive. Therefore, as a second approach, we sampled height, density, and age of living trees, and abundance and state of decomposition of dead woody material, along the same transect. This allowed a comparison of the structural characteristics in stands of fire origin and stands that appeared to have invaded the meadow without

fire. To detect possible correlations between tree establishment in meadows and macro-climatic factors, we computed multiple linear regressions using number of trees established during a given year as the dependent variable, and various measures of temperature and precipitation as the independent variables. The regressions were made using the SPSS program on a VAX computer at Fort Lewis College.

### Results

Since we began our field work in 1984, we have sampled over 450 stands and detected at least 75 fires that burned more than 10 ha in the last 400 years. We plan one more season of field work in 1987 to further clarify the boundaries of these burns. After that we will complete our analyses and write our final report.

In the meadow study, we found that forest stands of fire origin and stands apparently representing meadow invasion differ greatly in structure. Post-fire stands contain older trees (up to 400+ years old, depending on the date of the last fire), and generally large quantities of dead woody material in all stages of decomposition. By contrast, stands originating through meadow invasion are younger (125 years or less), with roughly even-aged bands of trees that become progressively younger as one approaches the forest-meadow border. These stands also contain very small quantities of dead woody material, indicating continual recruitment but little mortality in the tree population. We concluded that these structural characteristics are generally reliable criteria for distinguishing between lodgepole pine forests of fire origin and those representing meadow invasion.

Multiple linear regressions of tree establishment rate as a function of climatic variables showed generally low correlations (highest multiple  $R^2 = 0.24$ ), although the slopes of the regressions were highly significant ( $P < 0.001$ ). In analyses of each meadow separately and of the four meadows combined, we found that the variables most highly correlated with tree establishment were winter snowfall (negative correlation), summer precipitation (positive), and summer temperature (positive). However, because of the generally low  $R^2$  values obtained in the regressions, our tentative interpretation is that microclimatic factors (Patten 1969), including possibly snow accumulation patterns, are more important in controlling the meadow invasion than are the macro-climatic variables that we examined. We hope to look more closely at the meadows again this coming year before we draw any final conclusions, however.

### Conclusions

We are not yet ready to draw any conclusions at this time.

Literature Cited

- Miles, S. R. and P. C. Singleton. 1975. Vegetative history of Cinnabar Park in Medicine Bow National Forest, Wyoming. Soil Sci. Soc. of Amer. Proc. 39(6):1204-1208.
- Patten, D. T. 1969. Succession from sagebrush to mixed conifer forest in the northern Rocky Mountains. Amer. Mid. Naturalist 82(1):229-240.