

PLANT COMMUNITY DISTRIBUTION, DYNAMICS, FUEL LOADS, AND FIRE  
BEHAVIOR IN BRYCE CANYON NATIONAL PARK

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Objectives

This research program incorporates four primary objectives: (1) develop a comprehensive vegetation classification for Bryce Canyon National Park and to map the current and potential vegetation for the park; (2) develop a vital attributes succession model which depicts the successional development and disturbance response of plant communities in Bryce Canyon; (3) determine and characterize the fuel loads typical of each successional community type; (4) predict the behavior of fires occurring in each of the successional community types.

Methods

The vegetation classification used in this study employs an existing forest habitat type (potential vegetation) classification for the forests in southern and central Utah (Youngblood and Mauk 1985). Within each habitat type, successional community types were specified following the guidelines of Steele (1984). This successional community classification classifies forest communities by specifying the least shade tolerant species present and the dominant species as a binomial. Non-forest communities have been classified according to a site specific classification developed following the guidelines of Pfister and Arno (1980).

Vegetation maps have been prepared following a two-step procedure outlined by Roberts and Cooper (1989). During collection of plot data for community description, local areas surrounding the plot were mapped in the field. These ground truth data were then employed in a classification tree predictive model developed using CART (Breiman et al. 1984). The model takes the form of a dichotomous key which is used to

predict vegetation type in unsampled areas. Maps were prepared on mylar overlays for USGS topographic maps and then digitized for use with SAGIS, the park service GIS package.

The vital attributes model was developed following the guidelines of Roberts and Morgan (1989). Tree species were defined by a short set of autecological characteristics which were then used in a stochastic simulation model to predict community development and disturbance response. Fire return intervals and fuel load characteristics are specified for each habitat type. Fire occurrence is determined stochastically following the estimated fire return interval, and fire intensity is determined by time since last fire and fuel load characteristics. Species respond individually to fire intensity, and surviving age class distributions are calculated for each species. The model classifies each stand to successional community type using the age class distributions of species.

Fuel loads for each successional community type were determined by detailed sampling following the guidelines of Brown et al. (1982). For each community type, fuel loads were compared to similar community types using the Mann-Whitney or Kruskal-Wallis statistic (depending on number of community types). Statistically similar community types were pooled into fuel types, and fuel types were then mapped throughout the park using the community type maps.

For each fuel type, a fuel model was developed using the NEWMDL program (Burgan and Rothermel 1984). The fuel models were then entered into the BEHAVE program (Andrews 1986) to predict fire behavior under variable conditions at different times of year.

## Results

The plant community classification has been completed for all areas in Bryce Canyon National Park. A total of 17 habitat types were identified in Bryce Canyon National Park. Lower elevation sites (below the rim of the breaks) were often dominated by shrub communities (corymb buckwheat/salina wildrye or big sagebrush/four-wing saltbush) or pinyon-juniper woodland (pinyon pine/Utah juniper). Non-forest sites above the breaks are typically black sage/needle-and-thread communities, with local wet areas dominated by wiregrass/Ross's sedge.

Forest communities occur along a complex temperature-moisture

gradient, with lower elevation sites dominated by ponderosa pine, giving way with increasing moisture to Douglas-fir and then white fir. Quaking aspen occurs as a seral species in the more moist communities. Specific sites with unusual soil characteristics are dominated by blue spruce, limber pine, or Great Basin bristlecone pine.

The forest zones are subdivided into habitat types based on characteristic understory species. Low elevation ponderosa pine sites are often dominated by black sage or bitterbrush. Large areas of Bryce Canyon National Park in the ponderosa pine, Douglas-fir and white fir series are dominated by greenleaf manzanita. More moist areas are typically characterized by Oregon grape, western snowberry, and common juniper.

Within habitat types, a large range of successional community type can occur. In Bryce Canyon National Park, seven community types account for more than 80% of the area. In order, the most common community types are ponderosa pine/ponderosa pine, pinyon pine/Utah juniper, Rocky mountain juniper/ponderosa pine, ponderosa pine/white fir, black sage/needle-and-thread, ponderosa pine/Douglas-fir, and ponderosa pine/Gambel oak.

The vital attributes succession model is completed for the forest communities. Due to a lack of successional variation in non-forest communities, a non-forest successional was not created.

Analysis of the community type fuel loads resulted in eleven fuel types defined for Bryce Canyon National Park. These fuel types vary in total fuel load, distribution of fuel within time-lag classes, and nature of fuels. Predictions of typical fire behavior for each of the fuel types for each of five months (May-September) were prepared by summarizing typical weather and fuel moistures for the respective months. For each type, extreme conditions were also selected to prepare worst-case fire behavior predictions as well.

Fire behavior predictions include: rate of spread, flame length, reaction intensity (heat/unit area/unit time), and fire line intensity, all varying with slope and windspeed. Predictions were summarized in an extensive graphical appendix.

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