

# SUCCESSION FOLLOWING THE 1974 WATERFALLS CANYON FIRE

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## ♦ INTRODUCTION

In the early 1970's, the growing awareness of the potential ecological impacts of fire suppression and the threat of more intensive fires due to fuel accumulation in fire-suppressed forests prompted the National Park Service to allow some fires to burn (Grand Teton National Park 1974). One of the first "prescribed natural fires" in a western National Park was the Waterfalls Canyon Fire (WCF) in Grand Teton National Park (GTNP). It was ignited by lightning in July 1974. Amid much public controversy (Anonymous 1974), the fire burned 1414 ha before it was extinguished by snow in December.

In the following year, GTNP biologists established permanent plots within and adjacent to the WCF in forests dominated by subalpine fir, Engelmann spruce, and lodgepole pine, and which varied in fire severity and time since fire. The goal of the study was to document the effect of the 1974 fire by monitoring long-term changes in vegetation, breeding birds, and small mammals (Barmore et al. 1976). Data were collected from four study areas in 1975, 1976, 1977, and 1983 under the direction of William Barmore. In 1991 and 1992 we resampled the permanently-marked vegetation plots and breeding bird transects. Our objectives were to compile, analyze and interpret all of the data collected from the four study areas since 1975.

## ♦ METHODS

### VEGETATION DATA

In July, 1991, we relocated and sampled the understory and arboreal vegetation in each of three 15 x 25 m macroplots at the four permanent plot locations (mature unburned forest, 1932 burn, 1974 severe burn and 1974 moderate burn). We used the methods that were employed by Barmore et al. (1976) in the earlier surveys (See Doyle 1994). Voucher specimens were collected in 1991 for problematic species.

### BIRD DATA

Four breeding bird censuses were conducted between June and July, 1992, in conjunction with Rick Wallen, GTNP Biologist, at each of the 4 study areas (mature unburned forest, 1932 burn, 1974 severe burn, and 1974 moderate burn). Bird density was estimated using the transect survey method (Haapanen 1965, Kendeigh 1944), as utilized by Barmore et al. (1976) in 1975, 1976, 1977 and 1983. Each census was made between dawn and approximately 0900. The number of breeding pairs within ca 30 m on either side of a ca 1000 m transect was tallied. A single male or male/female pair was counted as one breeding pair.



## SMALL MAMMAL DATA

Small mammals were live-trapped in 1975, 1976, 1977 and 1983 under the direction of William Barmore in each of the four permanently-marked study areas. At each site, a total of 100 Sherman folding live-traps, 50 small (5 x 6.2 x 16.5 cm) and 50 large (7.5 x 9 x 23 cm), were laid out on a 50 x 100 m grid (0.5 ha). Each year, trapping occurred during one or two five-day periods. Considerable between-year variability existed in when and how often the traps were checked during each five day period as well as in the number of sampling periods per year. Based on our analysis of the small mammal data collected between 1975 and 1983, we concluded that inconsistencies in the method of data collection did not warrant further trapping in 1991 or 1992. Notably, a more detailed study of the distribution of small mammals in burned and unburned mature forests has been conducted recently by Stanton et al. (1991) in GTNP; the WCF mature forest and severe burn permanently-marked mammal grids were included in their study.

All data collected from the permanent plots between 1975 and 1992 have been stored in computer files and will be archived in the Resource Management Office in Grand Teton National Park.

## RESULTS

### PLANTS

Engelmann spruce *P. engelmannii* was the most successful pioneer tree in both the severely and moderately burned study areas following the WCF (Figure 1). In both recent burns, the 1991 sapling density of Engelmann spruce was greater than the density of subalpine fir *A. lasiocarpa* and lodgepole pine *P. contorta*. Engelmann spruce density was higher and variability between plots was lower in the moderately burned area, compared with the severely burned area (Figure 1). On the other hand, lodgepole pine sapling density was higher in the severely burned stand, but still second in density to Engelmann spruce. Subalpine fir density was low for all three plots in the severe burn, but was considerably higher in the moderate burn (Figure 1). In the moderately burned plots, subalpine fir is only slightly less important than Engelmann spruce.

Conditions were apparently more favorable for the establishment of subalpine fir in the moderate burn than the severe burn; in addition, more individuals of subalpine fir survived the moderate fire.

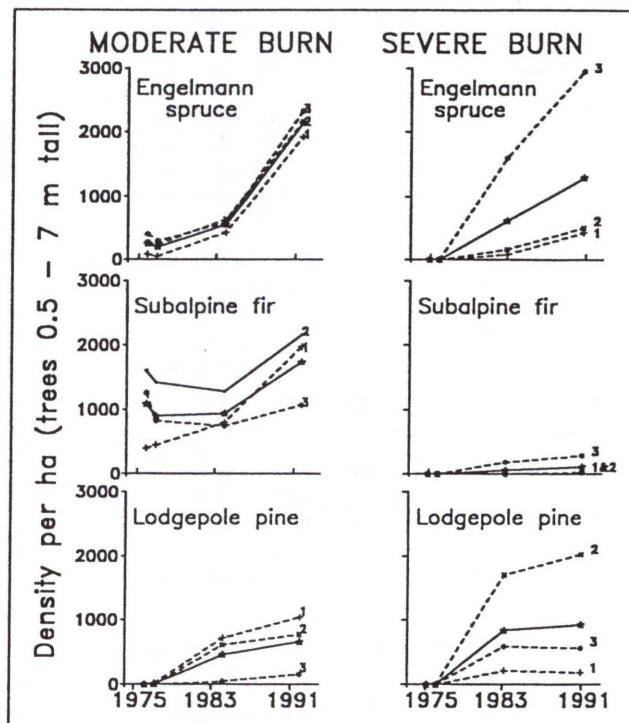


Figure 1. Live tree density for saplings (0.5 - 7 m tall) of the three major tree species. Data are shown for the 1974 moderately burned study area, and the 1974 severely burned study area. Data from each of the three macroplots are represented by a dashed line and plot number; the mean of the three plots is indicated by a solid line.

Understory species richness in the severely burned plots by 1991 was more than 2.5 times greater than in the mature forest plots, double that in the moderately burned plots, and 1.4 times greater than in the 1932 burn (Table 1).

Persistent species (those found in the mature forest and which emerged during the first post-fire year in the 1974 burns) played an important role during early succession. In the moderate burn, more than 90% of the total cover was from persistent species (Table 2). In the severe burn, greater than 54% of the total cover was from persistent species (Table 2). Transient species (not important in the prefire mature forest) were more important in the severe burn than the moderate burn.



Table 1. Understory species richness (excluding trees). Sixty quadrats (20 x 50 cm) were sampled within each study area.

STAND	Total	1975	1976	1977	1983	1991
Moderate Burn	27	11	16	15	20	20
Severe Burn	56	21	25	26	31	43
Mature forest	21	17	18	15	17	15
1932 Burn	40	29	31	29	30	34

Table 2. Relative percent cover of persistent understory species, i.e., species that are found in the unburned forest and presumably occurred on-site before fire.

STAND	1975	1976	1977	1983	1991
Moderate Burn	100%	96.3%	93.6%	90.9%	92.4%
Severe Burn	73.8%	67.1%	73.2%	67.7%	54.7%
1932 Burn	53.5%	61.8%	71.1%	69.0%	58.0%

More than half (59%) of the taxa in the moderately burned plots, and more than one third (35%) of the taxa found in the severely burned plots, were also found within the mature forest stand. Species which were successful in the moderate and severe burns throughout the first two decades, and were also found in the mature forest, include: elk sedge *Carex geyeri*, pinegrass *Calamagrostis rubescens*, globe huckleberry *Vaccinium globulare*, fireweed *Epilobium angustifolium*, hawkweed *Hieracium albiflorum*, heartleaf arnica *Arnica cordifolia* and spiraea *Spiraea betulifolia*.

## BIRDS

The habitat changes resulting from the 1974 WCF fire appear to have contributed to an increase in breeding bird species richness. In the moderate burn, species richness was greater than the mature forest in every year since the fire (Table 3). Bird species richness in the severe burn has exceeded that of the mature forest in all but the first two postfire years.

Few of the breeding bird species have been observed in all of the four study areas on a consistent basis since the fire. An exception is the dark-eyed

junco *Junco hyemalis*, which was sampled in each study area during each year. The chipping sparrow *Spizella passerina*, yellow rumped-warbler *Dendroica coronata*, and the American robin *Turdus migratorius* were also found fairly consistently in each of the four study areas over time.

Table 3. Breeding bird species richness. Data includes only birds surveyed within the belt transect.

STUDY AREA	1975	1976	1977	1983	1992
Moderate Burn	13	14	12	21	22
Severe Burn	4	8	11	19	21
Mature Forest	12	10	9	17	15
1932 Burn	9	5	5	8	13

Woodpeckers have been more abundant in the two recently burned areas than in the adjacent mature forest in all years since the 1974 fire. The relative abundance of woodpecker species has changed during the first two decades. For example, the northern three-toed woodpecker *Picoides tridactylus* was the most abundant species in the severe burn during the first post-fire year, but was absent from both the moderate and severe burn study areas by 1992.

Several species which are uncommon in the mature forest (e.g., white-crowned sparrow *Zonotrichia leucophrys*, western wood pewee *Contopus sordidulus*, mountain bluebird *Sialia currucoides* and house wren *Troglodytes aedon*) are more abundant in either or both of the 1974 burns. Mountain chickadee *Parus gambeli*, western tanager *Piranga ludoviciana*, ruby-crowned kinglet *Regulus calendula*, swainson thrush *Catharus ustulatus*, and gray jay *Perisoreus canadensis* are more common in the mature forest than either of the recently burned areas, and they are also more common in the moderate burn than the severe burn.

## SMALL MAMMALS

A total of eight species of small mammals were trapped in the five Waterfalls Canyon study areas between 1975 and 1983. Southern red-backed voles *Clethrionomys gapperi* and deer mice *Peromyscus maniculatus* were trapped most



frequently. Yellow-pine chipmunks *Eutamias amoenus* were also trapped at least once in all of the five areas.

Deer mice were trapped more frequently on recent burns in 1975, 1976 and 1977 than in the mature forest. However, in 1983, higher numbers of deer mice were trapped in both of the older forest study areas than in the recently burned study areas. Higher numbers of red-backed voles were trapped in the mature forest than in the other study areas. These data suggest that for these sites, the numbers of red-backed voles declined since before the fire.

## ◆ DISCUSSION

Other studies in the Rocky Mountain region have concluded that many of the plant species found on a site before fire will survive or reestablish after fire during the initial postfire year (Lyon and Stickney 1976, Armour et al. 1984, Anderson and Rommé 1991). Data from the WCF study illustrate that the initial floristic composition -- the seeds and propagules on site at the time of disturbance -- are important in postfire succession. Most of the species important during the first two decades of succession in both the severely and moderately burned areas were present on site at the time of the fire and emerged in the first postfire year. Many were components of the prefire vegetation, judging from their presence in the nearby mature forest. In contrast, only a handful of species absent from the mature forest were important during the first two decades of succession. Also supported by the WCF data is Stickney's (1990) assertion that burn severity will affect the relative importance of the survivor (persistent) and colonizer (transient) component of the postfire vegetation.

The three major trees that were dominant before the WCF (subalpine fir, Engelmann spruce, and lodgepole pine) became established soon afterwards. For the three conifers, the mechanism for postfire establishment is different from those of the most successful understory species, as they do not have the capacity to sprout. Seed availability, seed bed conditions, and moisture apparently contributed to the relative success of the different tree species. The importance of Engelmann spruce as a pioneer species in both the moderately and severely burned plots is consistent with other studies conducted in the northern Rocky Mountains (Whipple and Dix 1979,

Veblen 1986, Johnson and Fryer 1989), yet it may be one of the most unexpected results. Loope and Gruell (1973), in their treatise on the ecological role of fire in the Teton region, say that regeneration of Engelmann spruce is usually slow following fire. Taylor (pers. comm. 1992) indicated that the higher density of Engelmann spruce, compared with lodgepole pine in the severe burn was surprising.

The contrast in bird species composition, richness and relative abundance between the older stands and recently burned stands can be attributed to differences in habitat structure. Huff et al. (1984) found that the density and diversity of primary cavity nesting species and ground foraging species increased rapidly in the years following a fire, while canopy dwelling species declined. One year after the severe fire, when the burn was dominated by standing dead trees and very sparse ground cover, bird species richness was very low, yet the density of northern three-toed woodpeckers was high. The overall density of woodpecker species (primary cavity nesters) has remained higher in both 1974 burned areas than the older forests. Likewise, ground foraging species, namely the dark-eyed junco, chipping sparrow, American robin, common flicker *Colaptes auratus*, white-crowned sparrow, and house wren have been important in either or both the 1974 burns, but not the mature forest. The lower density of canopy dwellers, e.g., ruby-crowned kinglet, western tanager, gray jay and yellow-rumped warbler observed in the 1974 burns, especially the severe burn, can be attributed to the lack of canopy habitat after the fire.

With regard to small mammals, Stanton et al. (1991) found higher densities of red-backed voles in mature forests than recently burned sites, and higher densities of deer mice in recently burned forests. Aside from these trends, they concluded that it is difficult to make generalizations about the reaction of small mammals to fire. Stanton et al. (1991) attribute the lack of consistent response of small mammals to fire to the fact that small mammals respond to microsite characteristics, not to burned habitats per se. While the results from the WCF small mammal study concur with those of Stanton et al. (1991), reliable population estimates cannot be obtained from the WCF data based on high mortality levels and variability in sampling between years. These discrepancies make the small mammal data difficult to interpret.



The permanent plots that we studied, established by Grand Teton National Park scientists, are important in understanding succession in the region. However, data from the permanent plots only begin to explain the effect of the Waterfalls Canyon fire on the vegetation, breeding birds and small mammals, let alone the effect of fire in the Teton region as a whole. The long-term breeding bird and vegetation studies will continue to be an important chronicle of successional change following fire in a remote portion of GTNP but, the focus of our ongoing research is to understand the variability in plant establishment patterns and environmental conditions over larger areas.

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