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# Comparison of insects from burned and unburned areas after a range fire

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# COMPARISON OF INSECTS FROM BURNED AND UNBURNED AREAS AFTER A RANGE FIRE

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ABSTRACT.—Insect communities at recently burned and unburned sites in the Great Basin of northwestern Utah were studied by weekly sampling with pitfall and Malaise traps. More specimens were consistently collected at the burned site, although the numbers of species between the sites were about equal a month after the fire. Flying insects showing no preference for the sites were sciarids, phorids, and leafminer flies (all Diptera). Insects preferring the unburned site were mostly entomophagous flies such as pipunculids, chamaemyiids, and tachinids. Insects more common at the burned site were mosquitoes and phytophagous species of lygaeid bugs, leafhoppers, and moths. Seasonal trends in relative abundance of major families of flying insects are reported. Ground survivors included gryllacridids, carabids, tenebrionids, and ants. Silphids and buprestids immigrated into the burned area soon after the fire. Interrelationships between the burned area and the insect community are dicussed.

Fire is an important component of the rangeland ecosystem in the western United States. By consuming excess organic material, range fires release nutrients for future growth, stimulate regrowth of preferred forage species, and eliminate undesired plants. In many areas, repeated burnings perpetuate grasslands.

The effect of range fires on resident insect communities, however, is poorly known. Most of the previous research on the relationship between fire and insects were from the midwest. Rice (1932) studied the influence of fire on animals, including insects, in an Illinois prairie. Cancelado and Yonke (1970) reported the effect of prairie fire on insects in Missouri. Several studies on prairie burns and insect populations were conducted in Kansas (Nagel 1973, Knutson and Campbell 1976, Evans et al. 1983, Seastedt 1984).

The present study sought to ascertain insect survival immediately after a range fire in the Great Basin and detect immigration of the first potential phytophagous colonizers. Secondary objectives were to assess the immigration of predaceous and parasitic insects after a fire, and to determine the seasonal activity of adults of major insect groups in typical burned and unburned areas.

## MATERIALS AND METHODS

The study area was in Box Elder County, Utah, north of the Great Salt Lake between the Wildcat Hills and the Raft River Mountains. Elevation was between 1,340 and 1,460 m. Predominant native plants were big sagebrush, *Artemisia tridentata* Nutt.; winterfat, *Ceratoides* sp.; rabbitbrush, *Chrysothamnus* sp.; and western wheatgrass, *Pascopyrum smithii* (Rydb.) Löve. Major introduced species were cheatgrass, *Bromus tectorum* L.; crested wheatgrass, *Agropyron* spp.; and intermediate wheatgrass, *Thinopyrum intermedium* (Host).

On 7 July 1983 lightning started a range fire that burned at least 20,000 contiguous hectares. The fire, fueled by senescent cheatgrass, was hot enough to destroy most of the sagebrush cover.

The unburned (comparison) site, 24 km west of Snowville, Utah, was established on 20 May 1983 in an old plot (ca one hectare) of intermediate wheatgrass surrounded by sagebrush and rabbitbrush.

The burned site, ca 11 km south of the unburned site and at least 3 km within the boundary of the burn, was similar in slope and elevation to the unburned site. Insects were first sampled a week after the fire. Notes on revegetation were recorded during the season.

Insects were collected by two methods. Malaise traps, used for flying insects, were made of off-white polyester marquisette ma-

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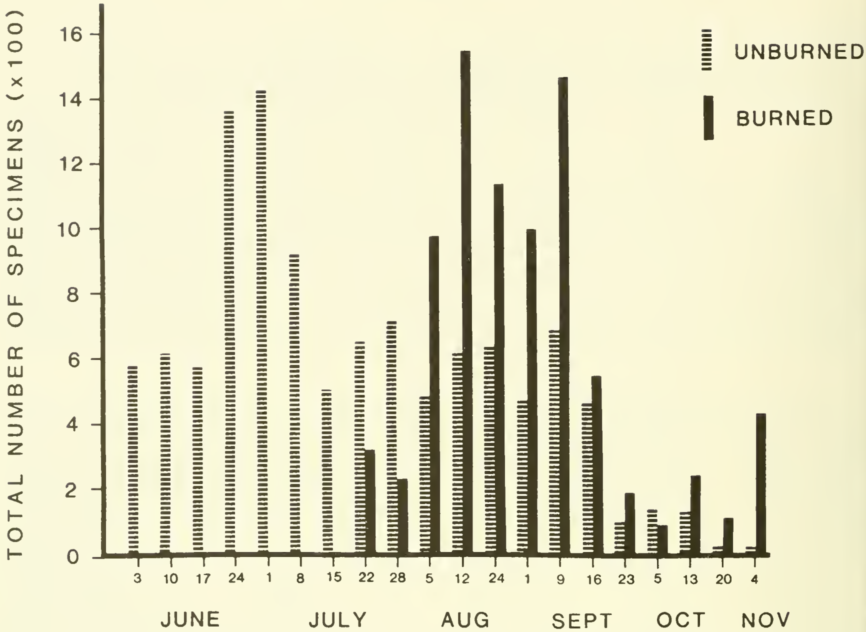


Fig. 1. The number of specimens in weekly Malaise trap collections from unburned site and burned sites in Box Elder County, Utah, during 1983.

terial, square in configuration with four central vanes, and each topped with a clear acrylic collecting tube. The traps were purchased from BioQuip Products (P. O. Box 61, Santa Monica, California 90406).[2] A trap was placed in the grassy area of the unburned site and another at the burned site.

Pitfall traps were used to sample ground inhabiting insects. The trap, similar to that described by Morrill (1975), was composed of a 4-oz plastic cup that collected specimens that fell through a funnel made of a 7-oz tapered plastic cup with the bottom cut out. This whole unit was housed in a 16-oz plastic cup and buried to surface level. At the unburned site, seven traps were arranged on a linear transect ca 20 m apart in the shrubby area; additional pitfalls were placed under and near the Malaise trap. At the burned site, 10 traps were ca 10 m apart along a linear transect near the Malaise trap.

[2]Mention of trade name is for identification only and does not imply an endorsement to the exclusion of other products that may be suitable.

Specimens from Malaise and pitfall traps were collected weekly from the establishment of study sites until 4 November 1983. Collections were not made during the weeks of 19 August and 27 October because of severe rain.

Insects were identified at least to the family level and separated by morphospecies (Janzen and Schoener 1968, Allan et al. 1975). Genus and, when possible, species were determined for abundant specimens. Moths could not be segregated into families because of the poor condition of samples from the Malaise traps.

## RESULTS

Althought the fire severely damaged vegetation, regrowth was evident by 29 July. In early September cheatgrass was plentiful and averaged ca 5 mm in height; sagebrush and rabbitbrush also recovered. In the following months, western wheatgrass became the dominant grass for the remaining sampling period.

Collection data from the Malaise traps showed that the number of specimens col-

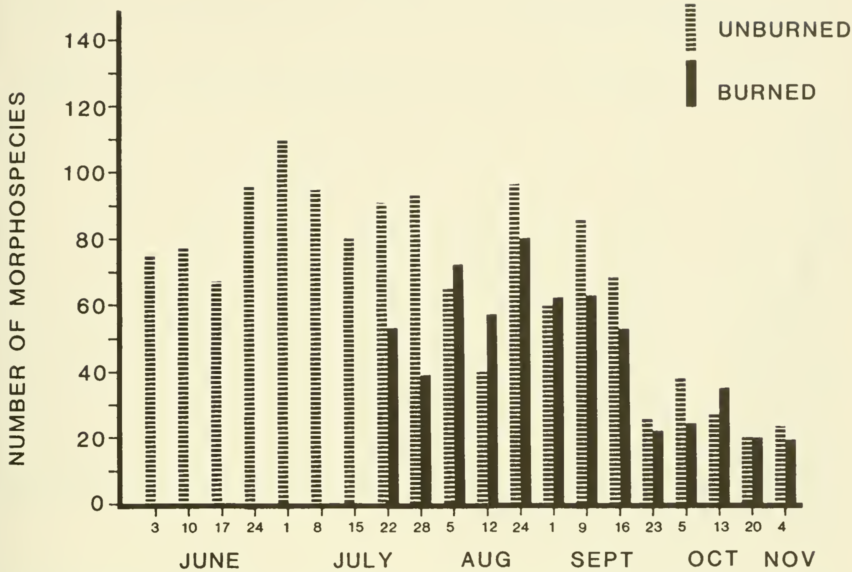


Fig. 2. The number of morphospecies identified from weekly Malaise trap collections either from an unburned site or a burned site in Box Elder County, Utah, during 1983.

lected at the unburned site peaked during the last two weeks in June and was higher than the burned site in the first two collections after the fire (Fig. 1). More specimens were consistently collected at the burned site, with the greatest amount in August and September. Numbers declined from mid-September through the fall.

Nearly all the specimens collected by the Malaise traps were adults from the winged orders (Homoptera, Hemiptera, Lepidoptera, Diptera, and Hymenoptera). Abundant families, however, were arranged by species. The number of species collected at the unburned site remained about the same before and three weeks after the fire (Fig. 2). Similar numbers of species were then collected at the burned site from August onward. Numbers at both sites decreased during fall.

To determine site preference, the collection data were grouped taxonomically. Most specimens were sorted to family only because of insufficient numbers at the morphospecies level. Abundant families, however, were arranged by species. Although Malaise traps were not intended to measure population density, they do indicate relative abundance. Major families, determined by the number of specimens, were grouped into three classes: those showing no preference or those clearly preferring either of the sites. Hymenoptera were clumped into two groups. Parasitic Hymenoptera contained Braconidae, Ichneumonidae, Mymaridae, Eulophidae, Encyrtidae, Eupelmidae, Eucharitidae, Pteromalidae, Eurytomidae, Chalcididae, Proctotrupidae, Ceraphronidae, Diapriidae, Scelionidae, Chrysididae, Bethylidae, Dryinidae, Tiphiidae, and Mutillidae. Predaceous Hymenoptera contained mainly pompilid and sphecid wasps.

Insects having no site preference were Sciaridae (mostly *Lycoriella* spp.), four unidentified species of Phoridae, 16 species of Agromyzidae, and many parasitic Hymenoptera (Table 1). Those preferring the unburned site were 15 species of Bombyliidae, 3 species of Pipunculidae (most were *Pipunculus* sp. and *Prothecus* sp.), 6 species of Chamaemyiidae, and 39 species of Tachinidae (with *Hyalomya aldrichii* Townsend and *Paradidyma singularis* Townsend the most

TABLE 1. Insects having no preference between unburned and burned sites in Box Elder County, Utah, during 1983 as shown by weekly Malaise trap collections.

| Collection date | Sciaridae | Phoridae | Agromyzidae | Parasitic[1] Hymenoptera |
|---|---|---|---|---|
| 3 June | 67[2] | 68 | 67 | 26 |
| 10 June | 55 | 31 | 9 | 28 |
| 17 June | 5 | 15 | 20 | 38 |
| 24 June | 7 | 57 | 72 | 18 |
| 1 July | 70 | 48 | 58 | 74 |
| 8 July | 53 | 113 | 39 | 159 |
| 15 July | 11 (0) | 74 (0) | 0 (0) | 34 (0) |
| 22 July | 16 (2) | 88 (2) | 43 (3) | 38 (8) |
| 28 July | 6 (11) | 125 (3) | 97 (4) | 20 (0) |
| 5 August | 0 (0) | 109 (48) | 12 (10) | 11 (14) |
| 12 August | 0 (0) | 45 (140) | 0 (0) | 5 (8) |
| 24 August | 0 (9) | 109 (60) | 7 (12) | 11 (11) |
| 1 September | 6 (6) | 19 (36) | 17 (46) | 6 (39) |
| 9 September | 80 (65) | 56 (25) | 9 (23) | 29 (29) |
| 16 September | 44 (5) | 22 (41) | 1 (6) | 42 (7) |
| 23 September | 1 (6) | 0 (0) | 11 (2) | 8 (4) |
| 5 October | 19 (12) | 0 (0) | 0 (0) | 17 (11) |
| 13 October | 37 (45) | 0 (0) | 1 (0) | 7 (76) |
| 20 October | 3 (3) | 1 (2) | 0 (0) | 9 (19) |
| 4 November | 4 (175) | 1 (4) | 1 (1) | 6 (202) |

[1]Parasitic Hymenoptera are Braconidae, Ichneumonidae, Mymaridae, Eulophidae, Encyrtidae, Eupelmidae, Eucharitidae, Pteromalidae, Eurytomidae, Chalcididae, Proctotrupidae, Ceraphronidae, Diapriidae, Scelionidae, Chrysididae, Bethylidae, Dryinidae, Tiphiidae, and Mutillidae.
[2]Data from burned site are in parentheses; otherwise, data are from unburned site.

common) (Table 2). Insects that preferred the burned site were Lygaeidae (almost all were the false chinch bug, *Nysius raphanus* Howard, plus some western bigeyed bugs, *Geocoris pallens* Stål), 31 species of Cicadellidae (dominated by *Empoasca aspera* Gillette & Baker, *Dikraneura carneola* [Stål], and *Parabolocratus viridis* Uhler), moths (mainly *Euxoa* spp., other Noctuidae, and microlepidopterans), three species of Culicidae [*Aedes dorsalis* (Meigen), *Culiseta inornata* (Williston), and *Culex tarsalis* (Coquillett)], and two families of predaceous wasps (Pompilidae and Sphecidae) (Table 3).

Specimens of certain families were collected in sufficient numbers to denote seasonal trends in adult abundance. Leafhoppers (Table 3) reached the highest levels at the end of June, decreased throughout the summer, but then increased at the burned site during the first week of September. Bombyliids (Table 2) were very rare until August, when numbers increased dramatically at the unburned site and remained at abundant levels through the first part of September. Phorids (Table 1) generally maintained their highest levels at the unburned site through July and August, although fewer were collected at the other site during this period. Chamaemyiids (Table 2) increased rapidly through July to peak at the end of August, then were gone by the end of September. Agromyzids had the highest peak in late July at the unburned site, then another lesser peak at the burned site during the last week of August.

Flying insects collected from pitfall traps were disregarded and only ground dwellers recorded. Specimens from the first collection at the burned site included *Stenopelmatus fuscus* Haldeman (Orthoptera: Gryllacrididae), several species of carabids, *Acmaeodera immaculata* Horn (Coleoptera: Buprestidae), some tenebrionids (mainly *Eleodes* spp.), and ants. Silphids (mostly *Nicrophorus* spp.) were taken two weeks later. All except *S. fuscus* and *A. immaculata* were also collected at the unburned site.

## DISCUSSION

Malaise traps were not designed to accurately estimate population densities. The traps are valuable, however, in detecting relative abundance, seasonal changes in numbers, species diversity, and flight activity and efficiently obtaining specimens of major pterygote orders (Evans and Owen 1965, Matthews and Matthews 1971). Cancelado

TABLE 2. Insects preferring the unburned site in Box Elder County, Utah during 1983 as shown by weekly Malaise trap collections.

| Collection date | Bombyliidae | Pipunculidae | Chamaemyiidae | Tachinidae |
|---|---|---|---|---|
| 3 June | 6[1] | 6 | 1 | 7 |
| 10 June | 4 | 4 | 0 | 21 |
| 17 June | 0 | 4 | 1 | 6 |
| 24 June | 3 | 4 | 1 | 11 |
| 1 July | 0 | 2 | 1 | 21 |
| 8 July | 2 | 0 | 0 | 13 |
| 15 July | 2 (0) | 15 (0) | 2 (0) | 7 (0) |
| 22 July | 3 (0) | 103 (0) | 19 (2) | 36 (3) |
| 28 July | 8 (1) | 78 (0) | 0 (0) | 12 (5) |
| 5 August | 9 (0) | 30 (0) | 30 (3) | 7 (17) |
| 12 August | 32 (2) | 34 (0) | 0 (0) | 97 (2) |
| 24 August | 24 (17) | 10 (0) | 43 (2) | 28 (56) |
| 1 September | 18 (2) | 16 (0) | 0 (1) | 95 (26) |
| 9 September | 18 (5) | 19 (0) | 1 (4) | 64 (15) |
| 16 September | 4 (2) | 55 (0) | 21 (1) | 61 (17) |
| 23 September | 0 (0) | 1 (1) | 1 (0) | 9 (8) |
| 5 October | 0 (0) | 3 (0) | 0 (0) | 13 (4) |
| 13 October | 0 (0) | 0 (0) | 0 (0) | 2 (3) |
| 20 October | 0 (0) | 0 (0) | 0 (0) | 0 (0) |
| 4 November | 0 (0) | 1 (0) | 0 (0) | 0 (0) |

[1]Data from burned site are in parentheses; otherwise, data are from unburned site.

and Yonke (1970) used Malaise traps to measure taxonomic differences in insect communities between burned and unburned areas of a Missouri prairie.

Malaise trap data from the unburned site showed seasonal patterns of adult insects (Fig. 2). Although more species were found at the end of June, the number of species fluctuated moderately at both sites, then decreased in mid-September. Seasonal environmental changes influenced species abundance. Grasses completed flowering by July and started senescing later that month, thus reducing the food supply for grass-feeding insects. Rabbitbrush, which started to bloom at the end of August and retained flowers until mid-October, provided food for many insects during the last part of the season. Evans and Murdoch (1968), by sampling a Michigan grassland with sweep nets and a Malaise trap, related the period of maximum species to the greatest availability of flowers. Food sources required to maintain the species richness level during midsummer were not apparent.

The largest weekly collections were from the burned site (Fig. 1). Many specimens were potential herbivorous colonizers (Table 3). Large numbers of false chinch bugs, which attack forbs and shrubs, may characterize areas disturbed by fire. In the same year as this study, I observed high densities of false chinch bugs (estimated at greater than 200 insects/m$^2$) after a large range fire (ca 4,400 ha) in Skull Valley, Utah. Cancelado and Yonke (1970) also reported collecting significantly more lygaeids from a burned area, but they did not identify the species.

Most leafhoppers were found just before the fire; numbers peaked again at the burned site the first week of September. At their grassland site, Murdoch et al. (1972) collected the largest number of Homoptera in June and July and found that insect diversity was highly correlated with both plant diversity and plant structure. Hawkins and Cross (1982), however, found no correlation between plant community parameters and insect diversity on reclaimed coal mine spoils in Alabama even though insect species richness seemed related to the densities of several plant species.

After the fire, more leafhoppers were collected from the burned site; other researchers reported similar observations (Cancelado and Yonke 1970, Nagel 1973). Major leafhoppers *D. carneola* and *P. viridus* were probably grass feeders (Thomas and Werner 1981), whereas *E. aspera* probably attacked forbs and shrubs. Hewitt and Burleson (1976) frequently found *D. carneola* on unburned rangeland in Montana.

TABLE 3. Insects preferring the burned site in Box Elder County, Utah, during 1983 as shown by weekly Malaise trap collections.

| Collection date | Lygaeidae | Cicadellidae | Lepidoptera | Culicidae | Predaceous[1] Hymenoptera |
|---|---|---|---|---|---|
| 3 June | 0[2] | 27 | 42 | 0 | 0 |
| 10 June | 0 | 122 | 93 | 0 | 0 |
| 17 June | 1 | 208 | 104 | 0 | 0 |
| 24 June | 4 | 881 | 34 | 0 | 0 |
| 1 July | 2 | 922 | 24 | 2 | 1 |
| 8 July | 2 | 234 | 38 | 4 | 1 |
| 15 July | 4 (0) | 194 (0) | 18 (0) | 0 (0) | 6 (0) |
| 22 July | 0 (0) | 145 (19) | 34 (94) | 1 (123) | 4 (6) |
| 28 July | 4 (2) | 122 (56) | 91 (2) | 3 (94) | 11 (0) |
| 5 August | 15 (324) | 73 (203) | 23 (174) | 0 (7) | 2 (33) |
| 12 August | 67 (1040) | 100 (63) | 101 (98) | 0 (0) | 3 (42) |
| 24 August | 148 (451) | 53 (239) | 36 (134) | 1 (9) | 3 (16) |
| 1 September | 37 (91) | 94 (127) | 43 (481) | 61 (77) | 1 (6) |
| 9 September | 154 (263) | 107 (291) | 40 (445) | 19 (239) | 8 (2) |
| 16 September | 36 (153) | 79 (95) | 33 (129) | 6 (48) | 2 (6) |
| 23 September | 10 (33) | 23 (54) | 9 (60) | 1 (0) | 0 (1) |
| 5 October | 11 (25) | 25 (20) | 2 (5) | 0 (1) | 0 (0) |
| 13 October | 21 (49) | 11 (2) | 5 (17) | 0 (2) | 0 (0) |
| 20 October | 1 (44) | 1 (2) | 2 (5) | 0 (9) | 0 (0) |
| 4 November | 1 (5) | 0 (2) | 2 (3) | 0 (9) | 0 (0) |

[1]Predaceous Hymenoptera are Pompilidae and Sphecidae.
[2]Data from burned site are in parentheses; otherwise, data are from unburned site.

Many of the moths taken at the burn site were *Euxoa* spp. The larvae, called cutworms, have a wide host range yet are rarely encountered because they inhabit soil.

Agromyzids were common at both sites (Table 1). They are an important component of rangeland because their larvae mine leaves and stems of grasses, forbs, and shrubs. Yet, agromyzids were at the burn site even though vegetation was poorly developed when the flies were collected.

Parasitic hymenopterans were regularly collected at both sites. Chalcids were never abundant, yet they represented ca 30 species in eight families. Mutillids, external parasites of larvae and pupae of various wasps and bees, were collected more often at the burned site. Later in the season, braconids and ichneumonids also were more common at the burned site; they parasitize caterpillars, beetle and sawfly larvae, maggots, various bugs, aphids, spiders, and other wasps. Other hymenopterans more abundant in the burned site were pompilids, which are spider-hunting wasps, and sphecids, which are predators of aphids, bugs, grasshoppers, planthoppers, leafhoppers, flies, caterpillars, beetles, bees, and spiders. Adults of all these entomophagous wasps are attracted to flowers. Flowers, prey, and potential hosts presumably were scarce at the burned site, yet wasps were common there.

Pipunculids were found only at the unburned site (Table 2). Their larvae are solitary internal parasites of nymphs and adults of Homoptera, particularly leafhoppers. Nevertheless, the burned site Malaise trap collections contained many potential hosts. Pipunculid biology, however, is poorly known and factors other than food supply may have influenced the flies to avoid the burned area. These flies may be good indicators of undisturbed areas because they were consistently absent from the burned site.

Cursorial insects were collected with pitfall traps. Although pitfall traps are limited in effectiveness (Greenslade 1964, Luff 1975), they have been successfully used to collect and compare surface arthropods from different sites (Fitcher 1941, Morrill 1975). The traps indicate that ants and ground-dwelling beetles survived the fire, probably escaping the heat by being below the ground surface. The fire did not destroy all organic material, such as brome seeds, so that food resources were available for ants to maintain their colonies and for the polyphagous beetles. Other studies have verified that ground insect populations are unharmed by fire or changes in vegetative architecture. Rice (1932) collected more ants on burned prairie in Illinois than on nearby control sites. Removal of shrubs from a shrub-steppe site in Wyoming did not adversely affect the abundance of tenebrionids and carabids (Parmenter and MacMahon 1984).

The collection data suggested that *A. immaculata* is attracted to stressed environments because specimens were only found in pitfall traps on the burned site. Many buprestid species are sensitive to smoke and heat, and the beetles may have been attracted by volatiles from burned winterfat, the host plant for the larvae. Furthermore, larvae may survive by feeding on the roots of damaged plants.

Pitfall traps commonly collected two other types of insects. Silphids may have entered pitfall traps to feed on the dead bodies of other insects. No apparent reason explained why the omnivorous Jerusalem crickets, *S. fuscus*, were not collected at the unburned site.

The present study raises several questions about the relationship between fire and the insect community. For example, why were so many predaceous and parasitic hymenopterans in the burned area (Table 3), especially when so few flowers and, presumably, potential hosts were present? Why did parasitic flies avoid the burned site that contained abundant potential hosts? Some groups, particularly leafhoppers and moths, apparently are attracted to burned areas, but unfortunately their means of orientation are not well known. Although only adults were examined in this study, this is the main life stage at which many insects disperse into various habitats.

Although fire is a common management tool for rangeland, this study raises important considerations of its use. Herbivorous insects seem very attracted to burned sites, yet their natural enemies, particularly parasitic flies, avoid those locations. Consequently, vegetative regrowth is highly susceptible to plant feeders and may be so severely stressed as to inhibit stand reestablishment. The abundance of insect herbivores also presents a danger to reseeding programs. Young vegetation is often highly susceptible to insect herbivory. Obviously, more research is needed to determine the long-term effects of range fires on insect and plant communities.

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