

Patterns of invertebrate recolonization following fire disturbance in Long Mesa, Mesa Verde National Park

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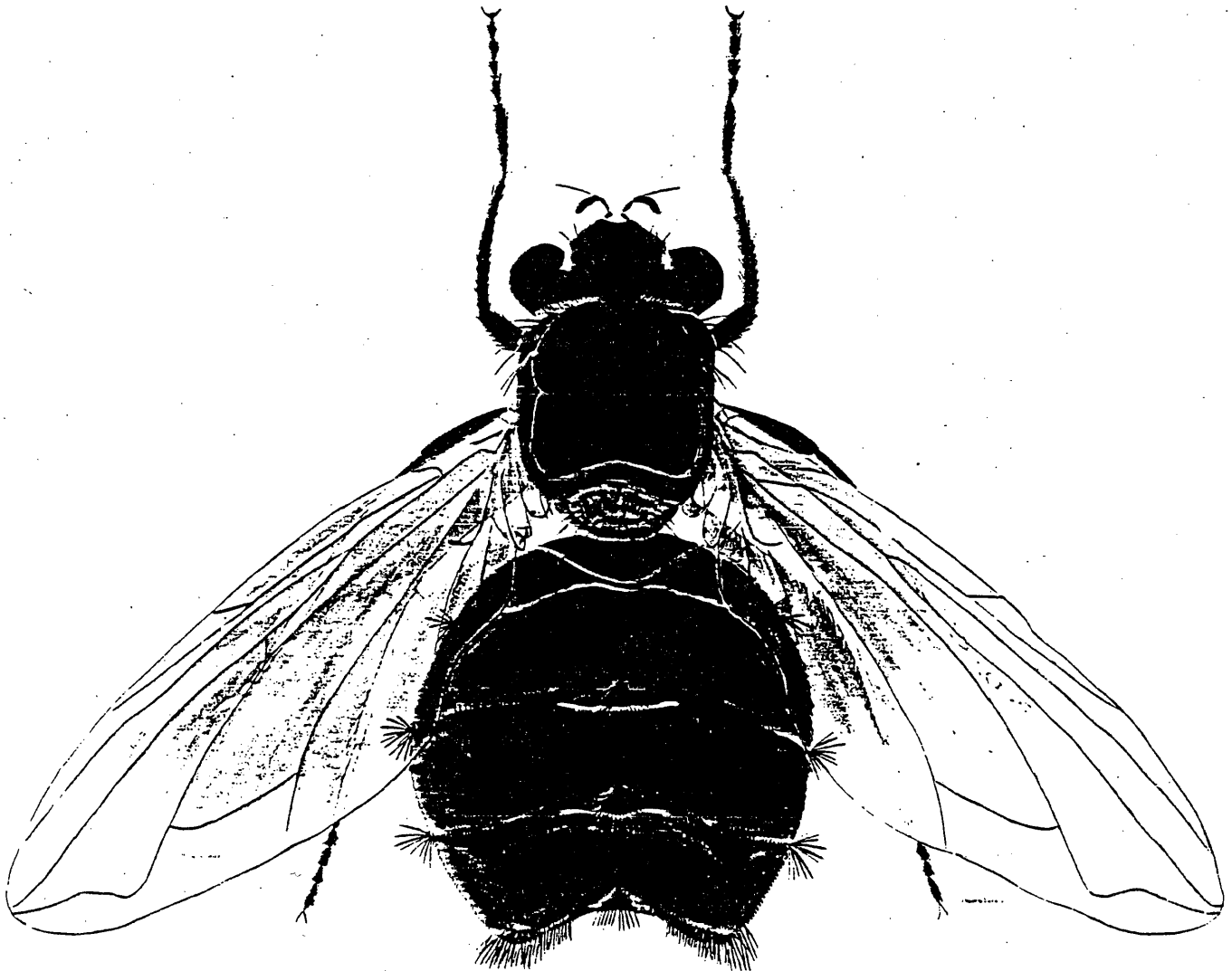


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ABSTRACT

Invertebrate community recolonization patterns were examined at 10 sites representing five different habitat types in fire burned and unburned areas in Mesa Verde National Park. In 1989 a wildfire burned a large area of the park and produced a mosaic of burned and unburned habitats. Fire opened the canopy and allowed for establishment of early successional plant communities. Both sweep net and pit trap sampling were used to examine the pattern of invertebrate recolonization of these fire burned areas. Established invertebrate communities were also examined in the unburned sites. The six most common orders of insects obtained from sweep-net sampling were as follows: Coleoptera, Diptera, Hemiptera, Homoptera, Hymenoptera, and Orthoptera. Densities of all orders were greater in burned sites compared to unburned areas. The three most common insect orders obtained by pit trap sampling were as follows: Coleoptera, Hymenoptera, and Orthoptera. There were greater numbers of individuals in Coleoptera and Orthoptera in burned sites compared to unburned sites. Numbers of Hymenoptera did not appear to differ between burned and unburned sites. Migratory ability of invertebrates in areas adjacent to the disturbed area, variation in vegetational architecture and diversity and severity of the disturbance may influence these differences. Fire burned areas also possess less leaf litter and permit greater physical movement of insect species. A representative sample of the invertebrates was examined for family and species diversity. Differences in species diversity between burned and unburned habitats were evident in the Coleoptera.

INTRODUCTION

Fire suppression has been practiced in Mesa Verde National Park for the last fifty five years. In 1989 a wildfire burned 1011.7 hectares of mountain shrub, meadow, and pinyon-juniper land throughout two canyons in Mesa Verde.

The effect of fire on invertebrate populations has received little attention. Studies have focused on attraction of invertebrates into burned areas. Buprestid beetles are known to be stimulated by the heat and smoke of newly burned areas (Linsley 1943). After a fire several invertebrate groups recolonize the burned areas. Fruit flies (Insecta:Diptera: Drosophilidae) of the genus *Drosophila* reinvade burned areas as soon as soil temperatures cool. Within one growing season the species composition within burned and unburned sites is essentially the same (Moore et al. 1979).

Ants (Insecta: Hymenoptera: Formicidae) commonly reinvade burned areas. The belowground location of ant nests often protects the colonies from the damaging effects of fire. Immediately following a fire, ants are often seen aboveground (McCoy and Kaiser 1990; O'Dowd and Gill 1984). Similar observations were recorded by Marilyn Colyer (Resource Manager, Mesa Verde Park, personal communication, 1991).

Spiders (Arachnida: Araneae) are also common in burn sites after a fire (Hauge and Kvamme 1983) and were frequently observed immediately after the Mesa Verde fire (Marilyn Colyer, personal communication). Both ants and spiders are highly mobile invertebrates and quickly reinvade burned areas.

In some cases fire disturbance actually opens favorable habitats for many species. Fire suppression may lead to a reduction in suitable habitat due to canopy closure, ground litter increase and grass and herb reduction (Mushinsky 1985; McCoy 1987). Fire

suppression practices lead to a decline in early successional habitats and have contributed to the endangered status of four butterfly species in Ohio (Shuey et al. 1987). Flat bugs (Insecta: Heteroptera; Aradidae) of the genus *Aradus* have also experienced population decline due to fire suppression (Heliovaara and Vaisanen 1983).

Fire may also lead to decreased populations of invertebrates. According to Whelan et al. (1980) fire caused a reduction in the numbers of acridid grasshoppers which allowed an increase survivorship of plant seedlings. Other species of arthropods, such as the land snail, *Modenia setosa* are sensitive to fire disturbance effects (Roth and Eng 1980).

The composition and diversity of the recolonizing invertebrate community after fire disturbance is dependent on several factors, including migratory ability of invertebrates in areas adjacent to the disturbed area, severity of the disturbance, and returning plant composition and diversity.

The following study was conducted at the 1989 Long Mesa burn site in Mesa Verde National Park. Invertebrate recolonization patterns were investigated in the summer of 1992 for five habitat types within the burned and unburned areas. The habitat types were as follows: mesa head meadow, mesa head shrub, pinyon-juniper, west canyon slope, and canyon bottom.

STUDY AREA

The following study was conducted at the 1989 Long Mesa burn site in Mesa Verde National Park. Invertebrate recolonization patterns were investigate for six habitat types within the burned and unburned areas. The habitat types were as follows: mesa head meadow, mesa head shrub, pinyon-juniper, west canyon slope and canyon bottom. Study areas are indicated by triangles (Appendix 1).

MATERIALS AND METHODS

Study sites: We sampled invertebrate populations from the six habitat types in the burned and unburned areas. The experimental plots were 12.5 meters square. Four centimeter diameter pitfall traps were placed in all twelve sites for the burned and unburned areas. Nine traps were placed in a 3*3 grid in each site. The traps were established 25 May and weekly collections of invertebrates were taken from the sites until 26 August.

Pitfall trap collection: The traps were filled with 40 ml of water. Water was used without additives because these may have affected the other animal fauna in the study area. The invertebrate fauna was sorted and placed in vials of 70% ethanol. The vials were then transported to the laboratory for identification.

Sweep net collection: Sweep net sampling was conducted every two weeks. A standard insect vegetation beating net was used for collecting the flying insect fauna (non-terriculous) (60 sweeps/study site). The samples were then transported to the laboratory for identification. The larger specimens were pinned and the smaller specimens were placed in vials of 70% ethanol. After a complete identification analysis, the invertebrate fauna will be deposited in the invertebrate museum collection at Mesa Verde National Park.

Trophic level and habitat designations. The key to numerical designations are as follows (Lavigne, unpublished):

Trophic Level	Code
Plant tissue feeder with chewing mouthparts	1
Plant sap feeder with sucking mouthparts	2
Pollen and/or nectar feeder	3
Entomophagous parasitoid	5
Omnivorous feeder-feeds on both plant and animal tissue	7
Saprophagous feeder-feeds on dead and decomposing matter	8

Habitat designations. The following list describes the sampling sites in the following tables.

Study site (habitat type)	Code
Canyon Head Meadow	2
Mountain Shrub Mesa Head	3
Pinyon-Juniper	4
Canyon West Slope	5
Canyon bottom	6
Burned sites	A
Unburned sites	B

Statistics: Kruskal-Wallis non-parametric tests for distribution differences was used to analyze the data for pit-fall trap and sweep-net sampling.

RESULTS

Sweep net sampling. The six most common orders of insects obtained from sweep-net sampling were as follows: Coleoptera, Diptera, Hemiptera, Homoptera, Hymenoptera, and Orthoptera. There were greater numbers of individuals in all orders in burned sites compared to unburned areas. This effect was particularly significant in the numbers of Coleoptera and Hemiptera (Fig. 1).

INVERTEBRATE RECOLONIZATION (MESA VERDE)

Sweep Net Analysis (Long Mesa)

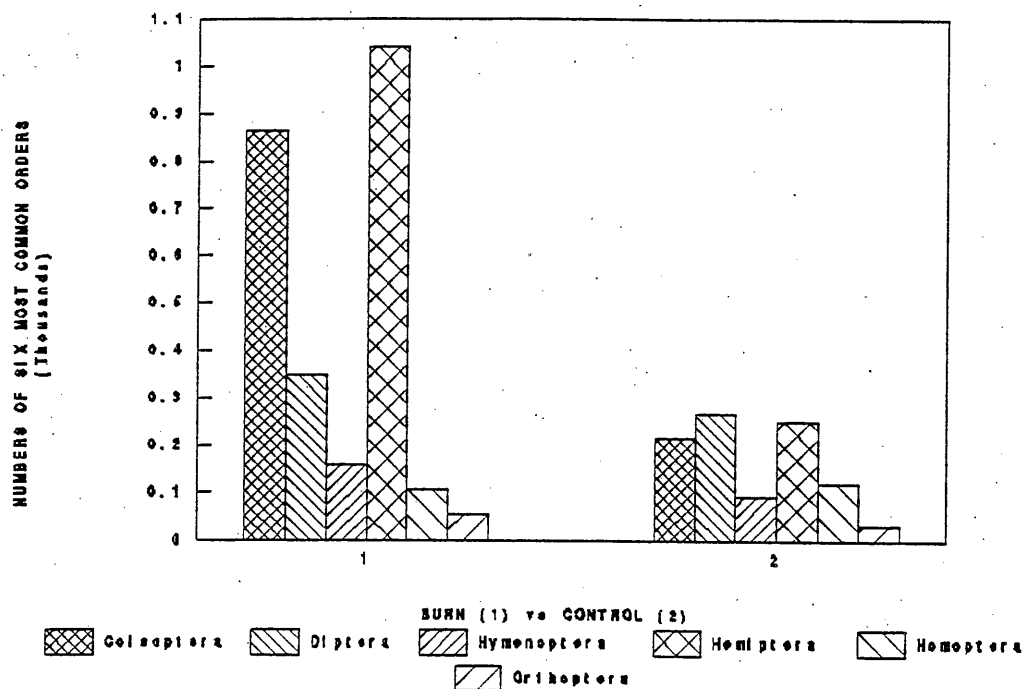


Figure 1: Invertebrate Recolonization (Mesa Verde National Park). The total number of organisms comparing burned to control areas in Long Mesa.

Pit trap sampling. The three most common insect orders obtained by pit trap sampling were as follows: Coleoptera, Hymenoptera, and Orthoptera (Fig. 2). There were greater numbers of individuals in Coleoptera and Orthoptera in burned sites compared to unburned sites (Fig. 2). Numbers of Hymenoptera did not appear to differ between burned and unburned sites (Fig. 2).

Diversity of species. Tables 1 through 7 represent a listing of insect species selected from representative samples collected at Mesa Verde National Park. Trophic levels refers to the feeding strategy of the insect. The final report will include the statistical analysis of trophic level and species diversity for all individuals and correlation with vegetational architecture in both burned and unburned areas.

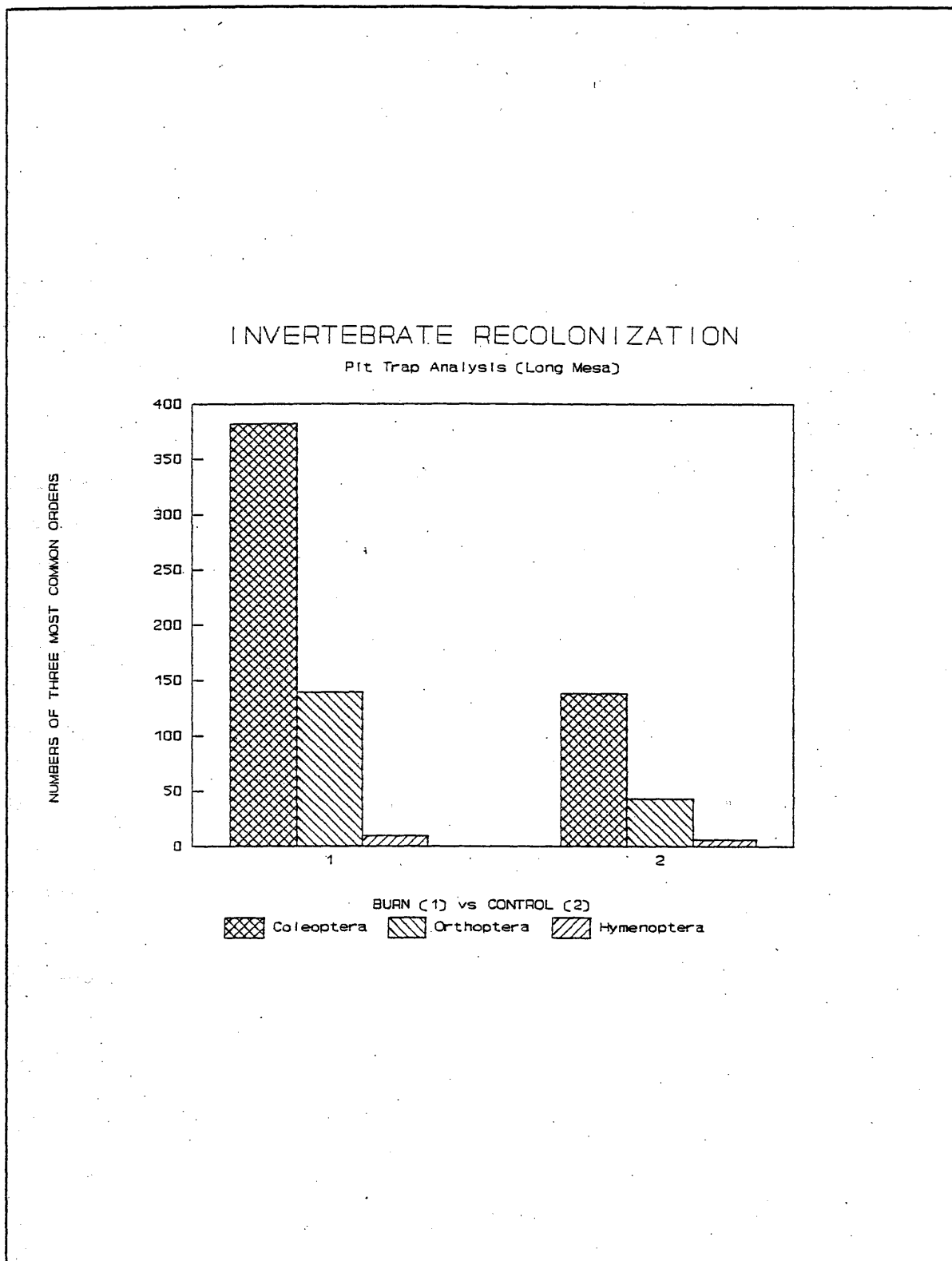


Figure 2: Invertebrate Recolonization (Mesa Verde National Park). The total numbers of the three most common orders are represented for Long Mesa burn and control sites.

Table 1. Taxonomic analysis of the order Coleoptera collected from Mesa Verde National Park. Trophic level refers to feeding strategy. Refer to materials and methods for trophic designations.

FAMILY	GENUS SPECIES	TROPHIC	SITE
Tenebrionidae	<i>Eleodes obscurus</i>	8	4A
Tenebrionidae	<i>Eleodes obscurus</i>	8	5A
Tenebrionidae	<i>Eleodes obsoletus</i>	8	3B
Tenebrionidae	<i>Eleodes obsoletus</i>	8	6B
Tenebrionidae	<i>Eleodes obsoletus</i>	8	5B
Tenebrionidae	<i>Eleodes obsoletus</i>	8	5A
Tenebrionidae	<i>Eleodes obsoletus</i>	8	4A
Tenebrionidae	<i>Eleodes obsoletus</i>	8	2A
Tenebrionidae	<i>Eleodes obsoletus</i>	8	2B
Tenebrionidae	<i>Eleodes obsoletus</i>	8	4A
Tenebrionidae	<i>Embaphion muricatum</i>	8	6B
Elateridae	<i>Ctenicera sp.</i>	1	2B
Elateridae	(Species #1)	1	3A
Elateridae	(Species #2)	1	6B
Elateridae	(Species #3)	1	2B
Elateridae	<i>Ctenicera sp.</i>	1	4B
Elateridae	<i>Ctenicera sp.</i>	1	5B
Coccinellidae	<i>Hippodamia convergens</i>	5	4B
Coccinellidae	<i>Hippodamia convergens</i>	5	2A
Coccinellidae	<i>Hippodamia convergens</i>	5	6A
Coccinellidae	<i>Hippodamia convergens</i>	5	3A
Coccinellidae	<i>Hippodamia convergens</i>	5	3B
Coccinellidae	<i>Hippodamia convergens</i>	5	6B
Coccinellidae	<i>Hippodamia convergens</i>	5	5A
Coccinellidae	<i>Hippodamia quinquesignata</i>	5	2A
Coccinellidae	<i>Hippodamia convergens</i>	5	2A
Coccinellidae	<i>Mysia sp.</i>	5	4B
Coccinellidae	<i>Brachyacantha dentipes</i>	5	6A

Table 1. Continued. Refer to materials and methods for trophic designations.

FAMILY	GENUS SPECIES	TROPHIC	SITE
Carabidae	<i>Pasimachus sp.</i>	5	3B
Carabidae	<i>Calasoma (Chrysostigma) lepidum</i>	5	3A
Carabidae	<i>Calasoma peregrinetum</i>	5	3A
Carabidae	<i>Calasoma (Chrysostigma) obsoletum</i>	5	5B
Carabidae	(Species #1)	5	5A
Carabidae	(Species #2)	5	2A
Carabidae	<i>Harpalus sp.</i>	5	4A
Carabidae	<i>Harpalus sp.</i>	5	6A
Curculionidae	<i>Magdalis lecontei</i>	1	4B
Curculionidae	(Species #1)	1	3B
Curculionidae	(Species #2)	1	2B
Curculionidae	<i>Curculio sp.</i>	1	2B
Curculionidae	<i>Curculio sp.</i>	1	6B
Curculionidae	(Species #2)	1	2A
Chrysomelidae	<i>Saxinus sp.</i>	1	6B
Chrysomelidae	<i>Systema blanda</i>	1	5A
Chrysomelidae	<i>Saxinus onogera</i>	1	6B
Chrysomelidae	<i>Monoxia sp.</i>	1	5A
Chrysomelidae	(Species #1)	1	6A
Chrysomelidae	(Species #2)	1	6B
Cleridae	<i>Trichodes ornatus</i>	5	4A
Cleridae	<i>Trichodes ornatus</i>	5	6B
Cleridae	<i>Trichodes ornatus</i>	5	5B
Cleridae	<i>Cymatodera sp.</i>	5	4B
Cerambycidae	<i>Judolia instabilis</i>	3	3B
Cerambycidae	<i>Gnathochaeops pratensis</i>	3	4A
Cerambycidae	<i>Gnathochaeops pratensis</i>	3	6B

Table 1. Continued. Refer to materials and methods for trophic designations.

FAMILY	GENUS SPECIES	TROPHIC	SITE
Buprestidae	<i>Acmaeodera sp.</i>	1	2A
Cicindelidae	<i>Cicindela purpurea audobonii</i>	5	2A
Cicindelidae	<i>Cicindela punctulata</i>	5	6A
Cantharidae	<i>Silis sp.</i>	3	3A
Histeridae	(Species #1)	5	2A
Meloidae	<i>Meloe sp.</i>	1	4B
Melyridae	<i>Collops sp.</i>	5	6A
Scarabaeidae	<i>Dichelonyx sp.</i>	8	2A
Scarabaeidae	<i>Dichelonyx sp.</i>	8	2B
Scarabaeidae	<i>Dichelonyx sp.</i>	8	3A
Scarabaeidae	<i>Dichelonyx sp.</i>	8	3B
Scarabaeidae	<i>Dichelonyx sp.</i>	8	6A
Scarabaeidae	<i>Dichelonyx sp.</i>	8	6B
Scarabaeidae	<i>Diplotaxis sp.</i>	8	2A
Scarabaeidae	<i>Diplotaxis sp.</i>	8	2B
Scarabaeidae	<i>Diplotaxis sp.</i>	8	5B
Silphidae	<i>Nicrophorus marginata</i>	8	5A
Silphidae	<i>Nicrophorus guttula</i>	8	2A
Silphidae	<i>Nicrophorus guttula</i>	8	4A

Table 2. Taxonomic analysis of the order Orthoptera collected from Mesa Verde National Park. Refer to materials and methods for trophic designations.

FAMILY	GENUS SPECIES	TROPHIC	SITE
Acrididae	<i>Anabrus simplex</i>	1	2A
Acrididae	<i>Xanthippus corallipes</i>	1	2B
Acrididae	<i>Arphia conspersa</i>	1	2A
Acrididae	<i>Arphia conspersa</i>	1	4B
Acrididae	<i>Psoloessa delicatula</i>	1	2A

Table 3. Taxonomic analysis of the order Hemiptera collected from Mesa Verde National Park. Refer to materials and methods for trophic designations.

FAMILY	GENUS SPECIES	TROPHIC	SITE
Pentatomidae	<i>Acrosternum hilare</i>	2	3A
Pentatomidae	<i>Thyanta sp.</i>	2	3A
Pentatomidae	<i>Thyanta sp.</i>	2	4A
Pentatomidae	<i>Thyanta sp.</i>	2	4B
Pentatomidae	<i>Holcostathus sp.</i>	2	4A
Pentatomidae	<i>Holcostathus sp.</i>	2	5A
Pentatomidae	<i>Codophila remote</i>	2	4A
Scutelleridae	(Species #1)	2	2B
Scutelleridae	(Species #2)	2	6B
Scutelleridae	<i>Homaemus sp.</i>	2	6A
Scutelleridae	<i>Homaemus sp.</i>	2	4B
Scutelleridae	<i>Eurygaster sp.</i>	2	2A
Reduviidae	<i>Apiomerus sp.</i>	5	6A
Coreidae	<i>Coriomens sp.</i>	2	6B
Alydidae	<i>Alydus sp.</i>	2	2A
Lygaeidae	<i>Lygaeus reclinatus</i>	2	6A
Lygaeidae	<i>Lygaeus reclinatus</i>	2	4B
Lygaeidae	<i>Lygaeus reclinatus</i>	2	2A
Lygaeidae	<i>Lygaeus reclinatus</i>	2	3B
Lygaeidae	<i>Lygus sp.</i>	2	2A
Lygaeidae	<i>Lygus sp.</i>	2	2B
Lygaeidae	<i>Lygus sp.</i>	2	3B
Lygaeidae	<i>Lygus sp.</i>	2	5A
Lygaeidae	<i>Lygus sp.</i>	2	5B
Lygaeidae	<i>Lygus sp.</i>	2	6A
Rhopalidae	(Species #1)	2	4B
Rhopalidae	(Species #2)	2	6A
Rhopalidae	(Species #3)	2	6B

Table 4. Taxonomic analysis of the order Hemiptera collected from Mesa Verde National Park. Refer to materials and methods for trophic designations.

FAMILY	GENUS SPECIES	TROPHIC	SITE
Cicadae	<i>Platypedia putnami</i>	2	ALL
Cercopidae	<i>Philaronia sp.</i>	2	2B
Cercopidae	(Species #1)	2	2B
Cicadellidae	(Species #1)	2	3B
Cicadellidae	(Species #2)	2	3A
Cicadellidae	(Species #3)	2	6B
Cicadellidae	<i>Cuerna sp.</i>	2	3B
Cicadellidae	<i>Xerophloea sp.</i>	2	2A

Table 5. Taxonomic analysis of the order Diptera collected from Mesa Verde National Park. Refer to materials and methods for trophic designations.

FAMILY	GENUS SPECIES	TROPHIC	SITE
Asilidae	<i>Asilus sp.</i>	5	6B
Asilidae	<i>Asilus sp.</i>	5	6A
Asilidae	<i>Holopogon sp.</i>	5	5A
Asilidae	<i>Machimus sp.</i>	5	3B
Asilidae	<i>Certopogon sp.</i>	5	6A
Asilidae	<i>Stenopogon inquinatus</i>	5	6A
Tipulidae	<i>Tipula sp.</i>	3	6A
Bombyliidae	(Species #1)	3	6A
Conopidae	<i>Myopa sp.</i>	3	2A
Syrphidae	<i>Chilomyia sp.</i>	3	2A
Tachinidae	<i>Peleteria sp.</i>	3	6B
Tachinidae	<i>Gonia sp.</i>	3	5B
Tachinidae	(Species #1)	3	6B
Tachinidae	(Species #2)	3	6B
Tachinidae	(Species #3)	3	6A
Empididae	(Species #1)	3	6A

Table 5. Continued. Refer to materials and methods for trophic designations.

FAMILY	GENUS SPECIES	TROPHIC	SITE
Scathophagidae	(Species #1)	3	3A
Sarcophagidae	(Species #1)	3	5A
Anthomyiidae	(Species #1)	3	2A,2B
Anthomyiidae	(Species #2)	3	3A,6B
Therevidae	<i>Ozodiceromya sp.</i>	3	4A
Therevidae	<i>Ozodiceromya sp.</i>	3	3A
Otitidae	<i>Tritoxa sp.</i>	3	4B
Otitidae	<i>Tritoxa sp.</i>	3	2A
Conopidae	<i>Physocephala texana</i>	3	4A
Syrphidae	<i>Eristalis tenax</i>	3	6A
Tephritidae	<i>Euaresta sp.</i>	3	6B

Table 6. Taxonomic analysis of the order Hymenoptera collected from Mesa Verde National Park. Refer to materials and methods for trophic designations.

FAMILY	GENUS SPECIES	TROPHIC	SITE
Halictidae	<i>Dielectus sp.</i> (#1 species)	3	6A
Halictidae	<i>Dielectus sp.</i>	3	3B
Halictidae	<i>Dielectus sp.</i> (#2 species)	3	2B
Halictidae	<i>Halictus sp.</i> (#1 species)	3	2A
Halictidae	<i>Halictus sp.</i>	3	2B
Halictidae	<i>Halictus sp.</i> (#2 species)	3	4A
Halictidae	<i>Halictus sp.</i>	3	5A
Halictidae	<i>Halictus sp.</i>	3	6A
Halictidae	<i>Lasioglossum sp.</i> (#1 species)	3	3B
Halictidae	<i>Lasioglossum sp.</i>	3	2B
Halictidae	<i>Lasioglossum sp.</i> (#2 species)	3	2A
Halictidae	<i>Augochlorella striata</i>	3	2B
Halictidae	<i>Agapostemon sp.</i>	3	3A
Halictidae	<i>Agapostemon sp.</i>	3	4A
Halictidae	<i>Ashmeadiella sp.</i>	3	4A

Table 6. Continued. Refer to materials and methods for trophic designations.

FAMILY	GENUS SPECIES	TROPHIC	SITE
Megachilidae	<i>Dianthidium</i> sp.	3	6A
Megachilidae	<i>Coelioxys</i> sp.	3	3B
Megachilidae	<i>Anthidium</i> sp.	3	4A
Megachilidae	<i>Megachile</i> sp.	3	6A
Megachilidae	<i>Osmia</i> sp. (#1 species)	3	2B
Megachilidae	<i>Osmia</i> sp. (#2 species)	3	3B
Megachilidae	<i>Osmia</i> sp.	3	6A
Anthophoridae	<i>Melitoma</i> sp.	3	3A
Anthophoridae	<i>Melissodes</i> sp.	3	2A
Anthophoridae	<i>Melissodes</i> sp.	3	6B
Anthophoridae	<i>Melissodes</i> sp.	3	4A
Anthophoridae	<i>Triepeolus</i> sp.	3	2A
Anthophoridae	<i>Nomada</i> sp.	3	2B
Anthophoridae	<i>Anthophora</i> sp.	3	3A
Anthophoridae	<i>Anthophora</i> sp.	3	6A
Andrenidae	<i>Andrena</i> sp.	3	3A
Andrenidae	<i>Andrena</i> sp.	3	6A
Andrenidae	<i>Andrena</i> sp.	3	3B
Andrenidae	<i>Andrena</i> sp.	3	2A
Andrenidae	<i>Andrena</i> sp.	3	4A
Apidae	<i>Bombus huntii</i>	3	2B
Apidae	<i>Bombus huntii</i>	3	5A
Apidae	<i>Bombus fervidus</i>	3	5A
Apidae	<i>Apis mellifera</i>	3	6B
Apidae	<i>Apis mellifera</i>	3	3A
Apidae	<i>Bombus nevadensis</i>	3	2A
Apidae	<i>Bombus nevadensis</i>	3	3B
Apidae	<i>Bombus nevadensis</i>	3	4A
Apidae	<i>Bombus nevadensis</i>	3	5A

Table 6. Continued. Refer to materials and methods for trophic designations.

FAMILY	GENUS SPECIES	TROPHIC	SITE
Pompilidae	<i>Palmodes carbo</i>	3	2A
Pompilidae	<i>Evagetus padrinus</i>	3	5B
Colletidae	<i>Colletes sp.</i>	3	6A
Tenthredinidae	<i>Tenthredo sp.</i>	3	3A
Tenthredinidae	(Species #1)	3	3B
Chrysididae	(Species #1)	3	3A
Chrysididae	(Species #2)	3	6A
Formicidae	(Species #1)	7	2B
Therevidae	(Species #1)	3	2A
Braconidae	(Species #1)	3	3A
Braconidae	(Species #2)	3	5B
Mutillidae	<i>Dasymutilla vestita</i>	3	4A
Mutillidae	<i>Dasymutilla vestita</i>	3	5A
Mutillidae	<i>Dasymutilla vestita</i>	3	5B
Ichneumonoidae	(Species #1)	3	2A
Ichneumonoidae	(Species #2)	3	2B
Ichneumonoidae	(Species #3)	3	6B
Philanthidae	<i>Philanthus gibbosus</i>	3	6B
Sphecidae	<i>Podalonia communis</i>	3	2A
Sphecidae	<i>Podalonia communis</i>	3	4A
Sphecidae	<i>Podalonia communis</i>	3	6A
Sphecidae	<i>Podalonia luctuosa</i>	3	3A
Sphecidae	<i>Podalonia luctuosa</i>	3	2A
Sphecidae	<i>Amnophila azteca</i>	3	2A
Sphecidae	<i>Amnophila azteca</i>	3	4A
Sphecidae	<i>Amnophila procera</i>	3	3B
Nyssonidae	<i>Gorytes canaliculatus</i>	3	2A
Nyssonidae	<i>Bicyrtes ventralis</i>	3	6B

Table 6. Continued. Refer to materials and methods for trophic designations.

FAMILY	GENUS SPECIES	TROPHIC	SITE
Eumenidae	<i>Stenodynerus</i> sp. (#1 species)	3	6A
Eumenidae	<i>Stenodynerus</i> sp. (#2 species)	3	2B
Eumenidae	<i>Stenodynerus</i> sp. (#3 species)	3	6B
Eumenidae	<i>Pterocleus quinquefasciatus</i>	3	6B
Eumenidae	<i>Mischocyttarus flavitarsis</i>	3	6B
Eumenidae	<i>Eumenes verticalis coloradensis</i>	3	6B
Eumenidae	<i>Eumenes crucifera nearcticus</i>	3	3B
Eumenidae	<i>Eurodynerus</i> sp. (#1 species)	3	4B
Eumenidae	<i>Eurodynerus</i> sp. (#2 species)	3	2A
Eumenidae	<i>Vespa pensylvanica</i>	3	4B

Table 7. Taxonomic analysis of the order Lepidoptera collected from Mesa Verde National Park. Refer to materials and methods for trophic designations.

FAMILY	GENUS SPECIES	TROPHIC	SITE
Arctiidae	<i>Lophocampa roseata</i>	3	3A
Lycaenidae	(Species #2)	3	6A
Lycaenidae	<i>Mitoura siva</i>	3	5B
Lycaenidae	<i>Coenonympha tullia ochracea</i>	3	5B
Noctuidae	(Species #1)	3	3B
Nymphalidae	<i>Euphydryas anicia</i>	3	3A
Nymphalidae	<i>Euphydryas anicia</i>	3	2B
Nymphalidae	<i>Limenitis weidemeyerie</i>	3	6A
Nymphalidae	<i>Phyciodes compestris</i>	3	6A
Nymphalidae	(Species #1)	3	4A
Nymphalidae	<i>Phyciodes</i> sp.	3	6A
Nymphalidae	<i>Vanessa cardui</i>	3	6A
Nymphalidae	<i>Phyciodes</i> sp.	3	2A
Pieridae	<i>Colias alexandra</i>	3	2B
Pieridae	<i>Pontia protodice</i>	3	6A
Pieridae	<i>Nathalis iole</i>	3	6B

Diversity patterns. An analysis of family and species diversity was performed on representative samples and may not reflect final diversity patterns. Family and species diversity over all habitat types for burned and unburned areas are presented in Table 8. Preliminary results based on representative samples indicate trends in species diversity variation between burned and unburned sites.

Table 8. Family and species diversity based on representative samples from burned and unburned sites across all habitat types in Mesa Verde National Park.

Order	Burned or unburned sites	Number of families	Number of species
Coleoptera	Burned	12	23
	Unburned	7	17
Orthoptera	Burned	1	3
	Unburned	1	2
Hemiptera	Burned	6	12
	Unburned	5	10
Homoptera	Burned	2	3
	Unburned	3	6
Diptera	Burned	12	17
	Unburned	5	10
Hymenoptera	Burned	17	35
	Unburned	14	33
Lepidoptera	Burned	4	10
	Unburned	4	6
Total	Burned	54	103
	Unburned	39	84

DISCUSSION

Differences between burned and unburned sites across all habitat types was evident in the abundance of individuals in Coleoptera, Hemiptera and Orthoptera (Figs. 1 and 2).

Family and species diversity variance, based on representative samples indicated differences in the order Coleoptera between burned and unburned sites (Table 7). Differences may reflect variations in vegetational architecture. Burned sites possessed early successional vegetation and unburned areas exhibited established plant communities. Insect assemblages living within these communities are influenced by plant species diversity and dominance. Fire burned areas also possess less leaf litter and permit greater movement of insect species through these areas.

Disturbances that physically remove vegetation from a habitat, such as fire or clear-cutting have dramatic effects on recolonizing insect communities. In Douglas fir communities of the Pacific Northwest, the greatest densities of invertebrates were collected from newly clear-cut areas (Mispagel and Rose 1978). However, these findings were a result of the activity of the increased numbers of highly mobile insects, such as spiders and ants (Mispagel and Rose 1978). Similar results are obtained following a fire (Hauge and Kvamme 1983; McCoy and Kaiser 1990). This increase may also be due to reduced leaf litter which allows for greater physical movement of highly mobile invertebrates.

Young-growth vegetative stands (20-year-old) that returned after clear-cutting possessed greater invertebrate species density than either mid-growth (125-year-old) or old-growth (450-year-old) forests in the Pacific Northwest. This increase may reflect the concomitant high diversity in understory vegetation (Mispagel and Rose 1978).

The ability of an insect community to return to pre-fire diversity or the "malleability"

of the system is due to the ability of insects to migrate from established communities into the disturbed areas (Chandler and Peck 1992) and to the vegetational species and architecture present after the fire (Quinn et al. 1991). Weak flying species do not recolonize newly clear-cut areas and may be of value in assessing disturbance of particular sites (Chandler and Peck 1992). The dominant plant community that returns after the disturbance is probably very important in predicting the recolonizing insect community structure (Quinn et al. 1991).

Patterns of invertebrate community reestablishment following a fire are dependent on the frequency and severity of the disturbance. Less severe disturbance shifts patterns only slightly, but more severe effects often facilitate vegetational succession which in turn influence the diversity and biomass relations of the recolonizing insects (Schowalter 1985). Early vegetation communities are characterized by ruderal (weedy) plants with increased productivity and decreased biomass compared to established communities. Plant fluid-feeding arthropods, such as homopterans and hemipterans successfully exploit this stage of vegetational succession. Defoliators, such as many Orthoptera and Coleoptera are subject to increased predation pressure in the more open canopy exhibited by early vegetative succession. Biochemical composition and concentration vary with plant age and species and may exert some influence on insects feeding on foliage (Schowalter 1985).

Later vegetation successional patterns are characterized by an increase in canopy height and ground cover. Such plant communities favor populations of defoliators, such as many Orthoptera and Coleoptera possibly due to the presence of greater numbers of enemy-free spaces (Schowalter 1985).

CONCLUSIONS

The significantly greater number of Coleoptera collected by both pit traps and sweep netting in burned areas may be of predictive value in analyzing the fire history of a region. Some insect species were found only in burned or unburned sites and may represent possible indicator species for disturbed and established areas.

The ability of invertebrates to recolonize disturbed areas is due to a combination of several factors, including mobility of the invertebrate species, returning vegetation composition and diversity, and severity of the disturbance.

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FINAL REPORT

Our final report will include a statistical analysis of differences in trophic level between burned and unburned sites. We will also analyze vegetational species diversity and percent coverage.

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Map of study sites

