Invertebrate Distribution and Diversity Assessment at the U. S. Army Pinon Canyon Maneuver Site

Presented to the U. S. Army and U. S. Fish and Wildlife Service

By

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2007 Report

Introduction

Insects fill several ecological roles in the biotic community (Triplehorn and Johnson 2005). Many species are phytophagous, feeding directly on plants; filling the primary consumer role of moving energy stored in plants to organisms that are unable to digest plant material (Triplehorn and Johnson 2005). Insects are responsible for a majority of the pollination that occurs and pollination relationships between host plant and pollinator can be very general with one pollinator pollinating many species of plant or very specific with both the plant and the pollinator dependant on each other for survival (Triplehorn and Johnson 2005). Insects can be mutualist, commensal, parasitic or predatory to the benefit or detriment of other animal populations, helping to keep those populations in balance (Triplehorn and Johnson 2005). Finally insects play a major role in removal of dead organic material and recycling those nutrients back into a usable form for other organisms (Triplehorn and Johnson 2005). Insect populations are major components of a community and should be studied as part of any comprehensive management of wildlife in an area.

In the summer of 2007, we initiated a base-line inventory of land dwelling invertebrates in three primary groups at Pinon Canyon Maneuver Site, a 244,000 acre U. S. Army installation with an ecologically-diverse patchwork of grassland, shrub land and woodland habitats (Shaw, et al. 1989). The three primary invertebrate groups were herbivores (grasshoppers), pollinators (bees, butterflies and moths), and predators (ground beetles, ladybeetles, and robber flies). These were not the only insects collected, but the groups we believe would be of primary importance to an evaluation of the arthropod species in the selected habitats.

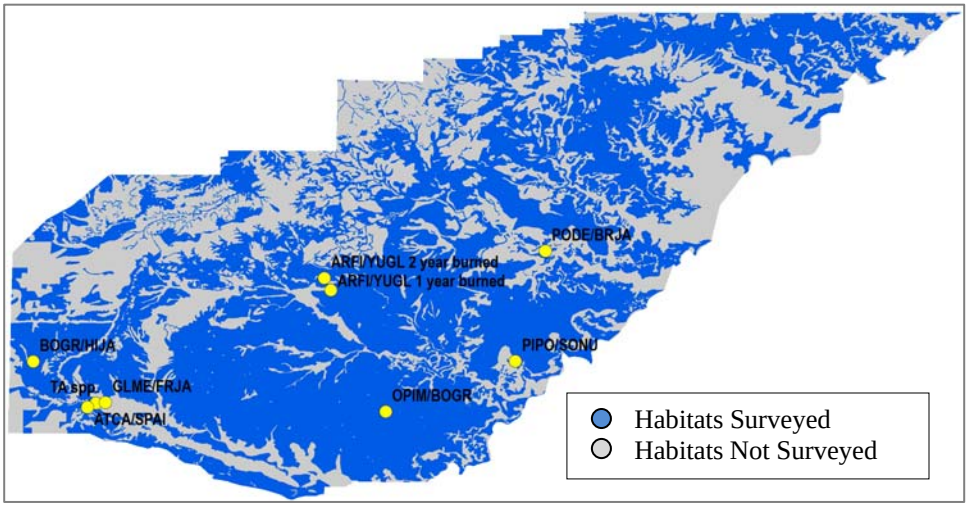

Fig. 1: Map of Pinon Canyon Maneuver Site with the collection sites labeled by abbreviation (Table 1).

In 1989, 26 plant communities were described in research conducted by Shaw et al. (1989). We followed their community descriptions to identify and establish insect collection sites in eight of the habitats and an additional habitat based on the presence of saltcedar, an invasive plant species (Fig. 1, Table 1). Productivity and diversity of plants is directly related to the diversity of arthropods associated with the habitats (Triplehorn and Johnson 2005), therefore we selected habitats we believed would have high productivity and divided our efforts among these habitats to allow for the highest diversity of insects to be collected. In this report, we list insects collected at Pinon Canyon Maneuver site in 2007 by species, the habitats in which they were located, and species that are rare or unusual in Las Animas County or of concern in Colorado.

Materials and Methods

Site Selection

Nine habitats and 10 sites (two sites for ARFI/YUGL (Table 1)) were selected to be sampled for this study (Fig. 1, Table 1). Habitats were selected for their unique dominate plant types, potential use by a specific insect known to be associated with a particular plant type, association with water, prevalence across Pinon Canyon Maneuver Site, the likelihood of the habitat to be impacted by use on the base by vehicular and personnel traffic, invasive plant species, or land management by fire.

Table 1: Pinon Canyon Maneuver Site habitats listed by scientific names, common names and habitat abbreviation. The habitat abbreviation is the first two letters of the genus and species of the primary plants in that habitat.

Collection Habitats and Abbreviations		
Plant species	**Common name**	**Habitat Abbreviation**
Bouteloua gracilis/Hilaria jamesii	Blue gramma/Galleta	BOGR/HIJA
Glossopetalon meionandra/Frankenia jamesii	Greasewood/James' Frankenia	GLME/FRJA
Atriplex canescens/Sporobolus airoides	Fourwing saltbush/Alkali sacaton	ATCA/SPAI
Opuntia imbricata/Bouteloua gracilis	Tree cholla/Blue gramma	OPIM/BOGR
Juniperus monosperma/Bouteloua eriopoda	One-seeded juniper/Black gramma	JUMO/BOER
Pinus ponderosa/Sorghastrum nutans	Ponderosa pine/Yellow indiangrass	PIPO/SONU
Populus deltoides/Bromus japonicus	Plains cottonwood/Japanese broom	PODE/BRJA
Artemisia filifolia/Yucca glauca (two sites)	Sand sagebrush/Small soapweed	ARFI/YUGL
Tamarix spp.	Saltcedar	TA spp.

Fig. 2: *Bouteloua gracilis* (Blue gramma)/ *Hilaria jamesii* (Galleta) habitat. BOGR/HIJA.

All habitat descriptions, except the Tamarisk (saltcedar) site follow Shaw et al. (1989). Plant species and common names associated with the habitats and their abbreviations for the habitats are found in Table 1 and in the figure captions. The first habitat we selected was BOGR/HIJA because of its prevalence across the base (Fig. 2). This type of habitat consists of grasses and small herbaceous plants with few vertical plant components. Many Orthoptera, primarily grasshoppers and Lepidoptera (particularly skippers) make use of grasslands, as well as, Hymenopteran and Lepidopteran pollinators nectaring on seasonally-blooming herbaceous plants (Glassberg 2001 and Michener 2000). Many species of skipper larvae feed on grasses and inhabit these areas (Glassberg 2001).

The GLME/FRJA habitat was selected because of the unusual dwarf milkweed plant associated with it (pers. com. Caron Rifici) (Fig. 3). The sparsely vegetated soils allows for actively hunting predators such as robber flies (Diptera: Asilidae) to more easily stalk their prey (Lavigne and Holland 1969) and we anticipated the Asilid community to be diverse in this area.

Fig. 3: *Glossopetalon meionandra* (Greasewood)/ *Frankenia jamesii* (James Frankenia) habitat. GLME/FRJA.

Fig. 4: *Atriplex canescens* (Fourwing saltbush)/ *Sporobolus airoides* (Alkali sacaton) habitat. ATCA/SPAI.

The ATCA/SPAI habitat (Fig. 4) serves as a resource for several species of skipper, one of which is only known to feed on four-wing saltbush both as larva and adult (Glassberg 2001).

Fig. 5: *Opuntia imbricata* (Tree cholla)/ *Bouteloua gracilis* (Blue gramma) habitat. OPIM/BOGR.

The OPIM/BOGR habitat is largely grassland, but incorporates some vertical structure and unique plant resources available to arthropods from the cacti (Shaw et al. 1989) (Fig. 5). Cacti serve as a seasonally-abundant supply of nectar and ripe fruit (Shaw et al. 1989) that might be used by some of our target insects. Blue gramma is a large component of the plant community across the base, therefore sampling this habitat in addition to the BOGR/HIJA habitat allowed us to diversify our collections where this grass was dominant.

Fig. 6: *Juniperus monosperma* (One-seeded juniper)/ *Bouteloua eriopoda* (Black gramma) habitat. JUMO/BOER.

The JUMO/BOER habitat attracts several species of Lepidoptera that use one-seeded juniper exclusively to complete their life cycle (Fig. 6). The site we chose was near a drainage area where water was present after rains, attracting some insects to the area. Asilids were also expected to be in high abundance in the area because of bare ground and availability of perching sites (Lavigne and Holland 1969).

The PIPO/SONU habitat was dramatically different from other areas at PCMS because of trees growing in very rocky sites with minimal soil and little additional vegetation (Shaw et al. 1989) (Fig. 7). This site is located along the upland cliff edge of a canyon and served as a good location for collecting insects using the canyon edge.

Fig. 7: *Pinus ponderosa* (Ponderosa Pine)/ *Sorghastrum nutans* (Yellow indiangrass) habitat. PIPO/SONU.

Fig. 8: *Populus deltoides* (Plains cottonwood)/ *Bromus japonicus* (Japanese brome) habitat. PODE/BRJA.

The PODE/BRJA, habitat was expected to be especially diverse due to its association with water and canyon areas which are rare at PCMS (Fig. 8). This habitat would be one of few where hydrophilic species such as dragonflies and aquatic beetles would occur.

Fig. 9: *Artemisia filifolia* (Sand sagebrush)/ *Yucca glauca* (Small soapweed) habitat site. ARFI/YUGL.

Two ARFI/YUGL habitats, 1 year post burn and 2 years post burn, were included in the project, giving us the opportunity to sample a habitat that was impacted by grazing pressure (Anderson and Inouye 2001, Hedrick et al. 1966) and had an array of insects known to be associated with these plants (Fig. 9). Sagebrush communities historically covered extensive areas of sandy soil in the Great Plains (Anderson and Inouye 2001). With the increase in land use for agriculture and cattle grazing, these areas were converted into crop land or grassland (Anderson and Inouye 2001, Hedrick et al. 1966). Use of the grassland requires the area be burned to reduce the chance of an accidental wildfire that could damage the plant and animal community or endanger military personal involved in maneuvers in this area (pers. com. Mead Klavetter). Several species of Orthoptera and Lepidoptera use these plants for a majority of their food supply (Glassberg 2001).

Fig. 10: *Tamarix* spp. habitat. TAsp.

In the *Tamarix* spp. (saltcedar) habitat, we collected pitfall samples only, allowing us to look at the impact of a monospecific invasive plant habitat for possible negative impacts on the invertebrate community (Fig. 10). This habitat was not included in Shaw's habitat types. We currently collect similar data at other saltcedar-infested sites in Colorado and Texas, and future comparisons across ecological regions are of importance, especially in regard to potential biological control projects.

Insect Collection Techniques

We used several types of collecting techniques, attempting to collect a representative sample of each of our target taxa: Asilidae (robber flies), Carabidae (ground beetles), Coccinellidae (ladybeetles), Apiformes (bees), Lepidoptera (butterflies and moths), and Orthoptera (grasshoppers and crickets) (Table 2).

Fig. 11: Pitfall trap installed with a new collection cup

Fig. 12: Pitfall trap with a collection of invertebrates.

Pitfall traps consisted of an 18 ounce Solo® cup buried in the ground even with the soil surface (Fig. 11). A collection cup with propylene glycol, which is non-toxic to vertebrates, was placed in the bottom of the cup to preserve the specimens and hasten the death of insects that fall into the cup (Fig. 12). A Solo® Cozy Cup with the bottom cut out to create a funnel was snapped into the lip of the buried 18 ounce Solo® cup to prevent larger insects from flying or crawling out of the trap. The entire pitfall opening was shaded by a 230mm by 230mm vinyl tile supported by nails to prevent overheating of the collected insects and divert rainfall (Fig. 11). The collection cup was replaced every two weeks. Insects were trapped by falling into the cup as they move along the ground. While some flying insects could fall into the trap, a majority of the insects collected were exclusively ground dwelling.

Fig. 13: Malaise trap.

Malaise traps consists of a single Bioquip® dark green Townsend-style trap with a modified wet/dry collection head (Fig. 13). The lid was modified with a clear top to allow more light to penetrate the trap. The collection head was filled with propylene glycol and the sample was poured out and replaced with fresh fluid every week. Insects were trapped by flying into the mesh panels at the base of the trap and then flying or crawling upward toward the light in the collection head. Once in the collection head, they died from intense heat or physical exhaustion and fall into the collection fluid. Although some insects can crawl from the ground into the trap, it rarely occurred, so this trap typically collected flying insects.

Sweep-net sample consisted of one 180˚ sweep 1 inch off the surface of the ground over an 18 inch wide strip with an aerial sweep-net. Those using the collecting method were trained to walk at a rate that would place the next sweep over an area not sampled by the previous sweep and limit the disturbance of the insects in the next sweep. This technique was best for collecting insects that sat on vegetation and do not typically crawl or fly. The contents of 20 sweeps were placed into a gallon Ziplock® bag and killed with ethyl acetate.

A beat-net sample consisted of sweeping vegetation firmly with a beating bag five times to knock arthropods on the vegetation into the bag. This sampling allowed us to collect sessile insects on larger vegetation such as trees and shrubs. Collected insects were picked off or poured out of the bag into a one-gallon Ziplock® bag and killed with ethyl acetate (Fig. 14).

Fig. 14: Jackie Brazille and Keith Wernert use the beat bag to collect invertebrates.

A butterfly survey consisted of three personnel visually observing butterflies and skippers in a habitat. The searcher walked through the habitat (avoiding other searchers or previously searched areas) for 15 minutes, recording the number of individuals of each species that was observed. For specimens that were not able to be identified on the wing, we captured the specimen, killed it by pinching the thorax which disabled the flight muscles, and placed it into a plastic Ziplock® bag.

Figure 15: Jackie Brazille uses the sweep net technique to collect invertebrates in the BOGR/HIJA.

Most butterflies collected during the butterfly surveys were not killed, but were identified in the field without capturing them. Butterflies that had to be captured for identification or voucher specimen purposes were pinned and retained in our collection.

Insects collected in a liquid (pitfall and Malaise traps) were brought back to the lab, rinsed with water to remove the propylene glycol and sorted according to the taxa interests of the project. To aid sorting, Muscoid flies and ants were removed from the sample and discarded. Samples collected dry and placed into a Ziplock® bag were sorted to remove all plant debris and then stored in a freezer. All Lepidoptera, Carabids, Asilids, Coccinellids and Hymenoptera were pinned. Orthoptera were pinned or preserved in alcohol. Pinned specimens were labeled and serve as voucher specimens for this project. Specimens preserved in alcohol degraded quickly and were discarded after identifications were made. Two groups of non-target taxa, Araneae (spiders) and Hemiptera (true bugs), have been sent to volunteer taxonomist for identification as the specialist has time. All remaining non-target taxa were placed into alcohol or pinned to serve as voucher specimens.

Butterflies were identified by Joy Newton, Jackie Brazille, Keith Wernert, and Vanessa Carney, under the supervision of Joy Newton, using “Butterflies through Binoculars the West” (Glassberg 2001). Carabid beetles were identified by Dr. Daren Pollock, Eastern New Mexico University, Portales, NM.

Coccinellids were identified by Dr. Jerry Michels. Asilids, Orthopterans and bees were identified by Joy Newton using published keys (Otte 1981 and 1984, Capinera and Sechrist 1982, Wood 1981), insect field guides (Capinera et al. 2005), comparing with specimens in the WTAMU collection, and observations based on morphological differences when keys were not available. Juvenile individuals were not typically identifiable and were discarded. Some specimens were not readily identified and have been sent to specialists for confirmation.

Table 2: Quick reference table of collection techniques used in 2007.

Collection Techniques used in the Habitats
For each habitat we collected the following samples: 1. Nine pitfall traps sampled every two weeks continuously from June 6 to October 11. 2. One malaise trap sampled every week from June 6 to August 21. 3. Two sweep-net samples consisting of 20 standardized sweeps with an 18 inch heavy duty Bioquip® sweep-net collected once every other week. 4. Two beat-net samples consisting of 2 samples of 5 beats per sample collected once every other week. 5. A butterfly survey consisting of 3 observers walking a haphazard path through a habitat for 15 minutes once every other week. 6. The saltcedar site was a small, dense area that limited the sampling of invertebrates to pitfall trapping.

Each target insect that was collected and identified was entered into a master spreadsheet using Microsoft Excel. Shannon's Diversity Index, Modified Simpson's Index, total abundance of individual species, species richness and evenness of species were calculated in Microsoft Excel for each habitat, collection type and time period (Magurran 1988). The data were analyzed using SPSS version 14.

Results

We collected or observed, pinned and identified over 15,000 individual insects in our 5 target groups. We observed 1,724 butterflies in our butterfly surveys, 9,509 Orthoptera (mainly in pitfalls), 72 Coccinellidae (mainly in sweep-net samples), 4,694 Carabidae (mainly in pitfalls), 76 Asilidae (mainly in malaise traps), and 101 Apiformes from sweep-net, pitfall and malaise traps. In addition to the target taxa, we identified 58 different families of insects. We also collected other arthropods such as Diplopoda (millipedes), Chilopoda (centipedes) and Arachnida in the process of collecting for Insecta. Collected Arachnids included Acari (mites), Araneae (spiders), Pseudoscorpiones (pseudoscorpions), Scorpiones (scorpions), and Solipugidae (sun spiders). We do not yet have identifications of Araneae and Hemiptera from the specialists who are voluntarily working on these groups. A few Carabidae that were difficult to identify are still in the hands of specialists. Those individuals will be included in an addendum to this report. Species identified are listed in Appendix 1. Target species collected systematically by one of our five sampling regimes are listed in Appendix 2 with presence or absence of that species by habitat.

We observed some species of insect only in particular habitats, even though equal sampling effort was used in the habitats (Appendix 2). Other species appear to be habitat generalists and were found in almost all habitats (Appendix 2). We collected few species in the Ponderosa pine habitat (Table 4). Although, diversity was high in this habitat, most insects observed in the habitat were only flying

through the habitat and this was most evident with the butterflies. Other habitats had more persistent numbers of insects and the butterflies observed were directly using resources in the habitats, such as flowering herbaceous plants, laying eggs or mating. None of these behaviors were observed in butterflies in the Ponderosa pine habitat. The Juniper habitat had the highest diversity index, but like the Ponderosa pine habitat, this diversity is probably inflated because of the uneven distribution of species as indicated by the high calculation of evenness. The highest number of species was collected in the cottonwood habitat (Table 4). The cottonwood habitat consistently yielded the highest abundance and overall diversity of butterflies than the other sites. Butterflies were present at this site at every sampling period. The two sandsage habitat sites had very similar species and abundance during the summer. However, later in the fall when pitfalls only were collected, there were more individuals in the one year burned area than in the two year burned area. At the sand sage sites, we collected a majority of the individuals of a nocturnal, flightless Carabid *Amblycheila cylindriformis*, the largest tiger beetle in North America. The sand sage sites were also abundant with butterflies. The cactus habitat collected a large number of individuals, particularly Orthopterans, but its diversity was low compared to other native habitats. The *Tamarix* spp. habitat had very low diversity, 0.49 point lower Shannon's diversity than any other habitat. This is consistent with an invasive monospecies habitat (Barrows 1996). The grassland habitat was very diverse with a moderate evenness. It was heavily used by butterflies in the Hesperidae family (skippers). The shrublands in our study, the black greasewood and the four-wing saltbush, had a moderate diversity, but each was a site to a few species of butterfly that were found primarily in that habitat and with the highest abundance. The black greasewood site had very high numbers of the smallest butterfly in North America the Western Pygmy Blue, *Brephidium exile*. The Saltbush Sootywing, *Hesperopis alpheus*, was only found near four-wing saltbush, even when found in another habitat.

Collection techniques varied in their ability to collect insects in our target taxa (Table 3). Beat-net samples collected the fewest individuals in our target groups. Sweep-net samples collected almost as many species as Malaise traps, but Malaise traps collected unique species and sweep-net sampling yielded similar species compared with pitfall collection techniques.

Table 3: Total specimens, number of species, and diversity indices for five collection methods at Pinon Canyon Maneuver Site, 2007.

Collection method	Total individuals collected	Species	Shannon's Index	Shannon's Evenness	Modified Simpson's Index
Pitfalls Trap	12692	167	2.72	0.53	0.85
Butterfly Survey	1724	38	2.68	0.74	0.91
Sweep-net	350	52	2.90	0.73	0.90
Malaise Trap	156	51	3.41	0.87	0.95
Beat Sample	1	1	0.00	0.00	0.00

Total individuals collected by habitat varied (Table 4). The highest number of individuals was collected from the ARFI/YUGL and it had the highest species diversity. A large number of individuals were collected from the TA spp. (Table 1) habitat, but relatively few species and low diversity. This may be due to differences in collection effort, but pitfall-only analyses yielded very similar results. Pitfall traps were the largest source of individuals collected across collection techniques. The lowest number of

individuals and species was collected from the PIPO/ SONU habitat. However, this habitat had diversity indices rivaling the ARFI/YUGL habitat sites.

Table 4: Total specimens, number of species, and diversity indices for collections from 10 sites at Pinon Canyon Maneuver Site, 2007.

Habitat	Shannon's Index	Shannon's Evenness	Modified Simpson's Index	Total Individuals collected	Species
JUMO/BOER	3.29	0.74	0.93	670	87
BOGR/HIJA	2.88	0.67	0.90	1645	75
ARFI/YUGL2	2.81	0.62	0.87	1985	94
PIPO/SONU	2.73	0.91	0.92	43	20
ATCA/SPAI	2.59	0.59	0.83	1625	80
ARFI/YUGL1	2.45	0.54	0.82	3391	92
GLME/FRJA	2.37	0.55	0.73	1111	72
PODE/BRJA	2.33	0.54	0.81	1757	73
OPIM/BOGR	2.06	0.47	0.74	1863	83
TA spp.	1.57	0.46	0.67	794	30

Proportional species abundance was calculated for each target group in order to illustrate the group composition (Figs.15-21). Proportions were calculated by taking the abundance of each species divided by the total abundance of individuals in the group. The proportional species abundance for Orthoptera was overshadowed by the large number of crickets (*Gryllus pennsylvanicus*, and *Ceuthophilus* spp.) collected in the samples (Fig. 19). These two species masked differences among the Acrididae, which we believe to be a more important target group of herbivores than Orthoptera in general. Therefore the Acrididae are presented in separate figures (Fig. 20 and 21). For large tables, the table has been modified to easily view differences between species, with the highest percentage table being presented first.

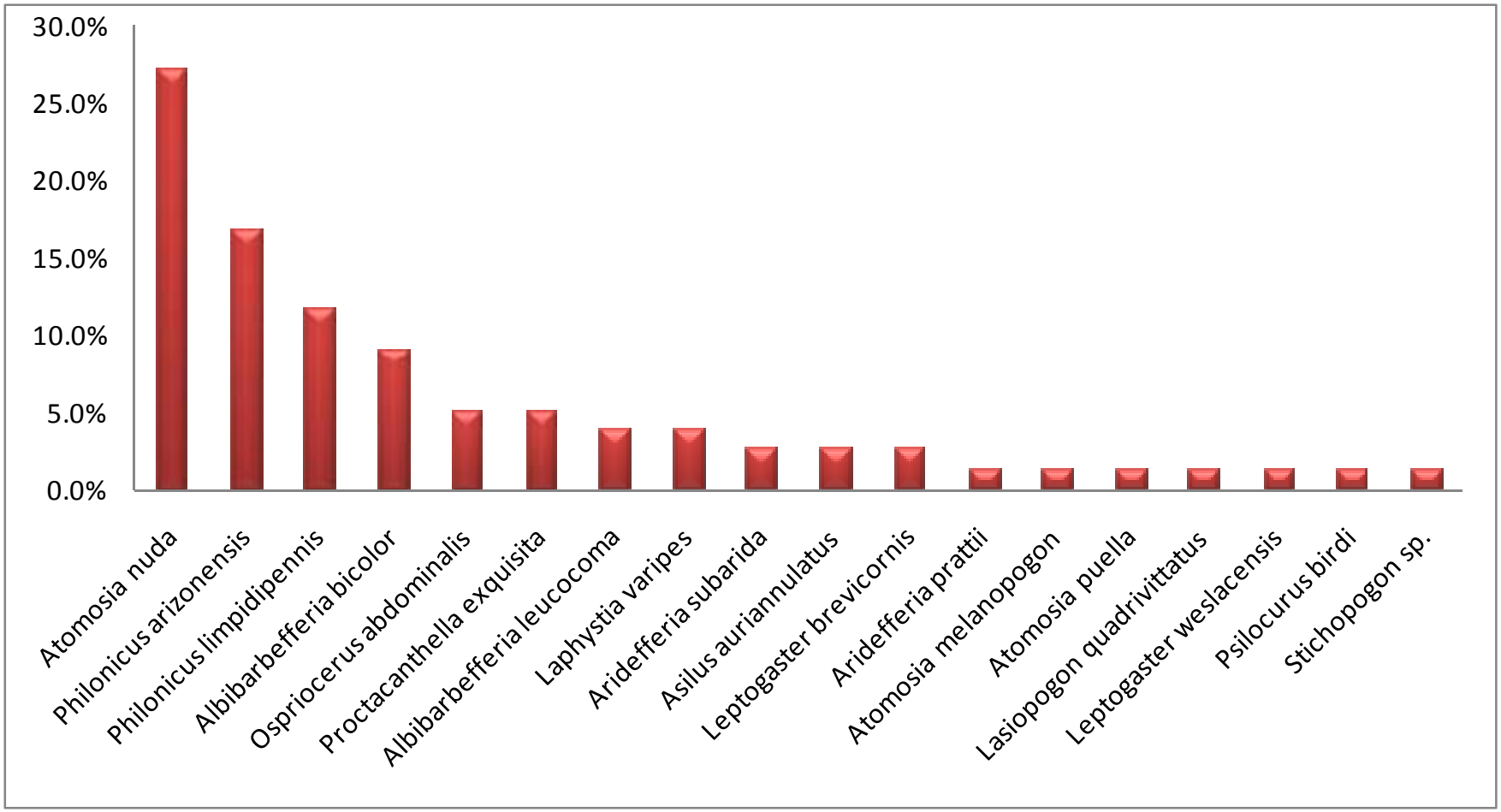

Fig. 15. Asilid species abundance calculated as a proportion of the total abundance of Asilidae for the entire year. Pinon Canyon Maneuver Site, 2007.

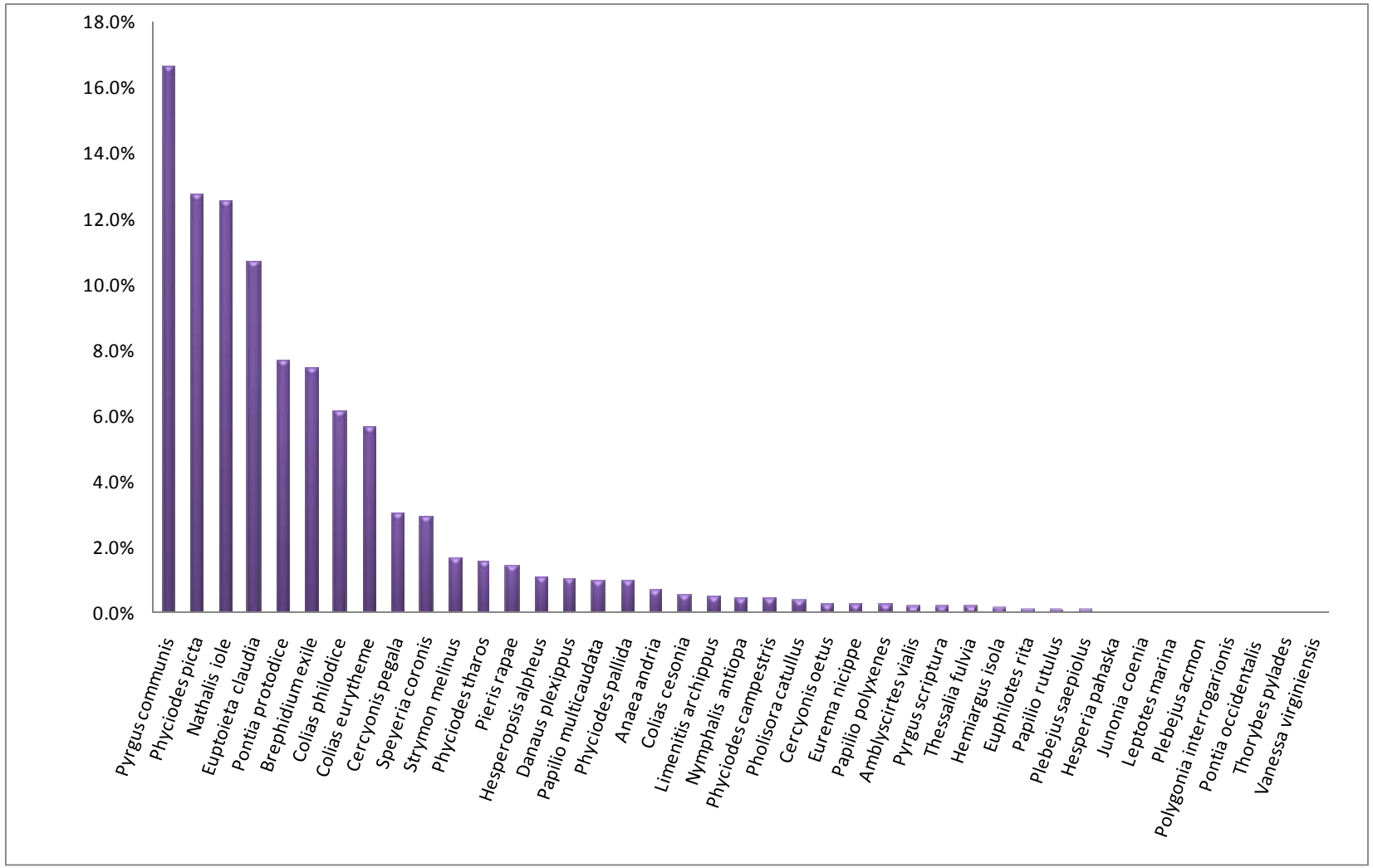

Fig. 16. Butterfly species abundance calculated as a proportion of the total abundance of butterflies for the entire year. Pinon Canyon Maneuver Site, 2007.

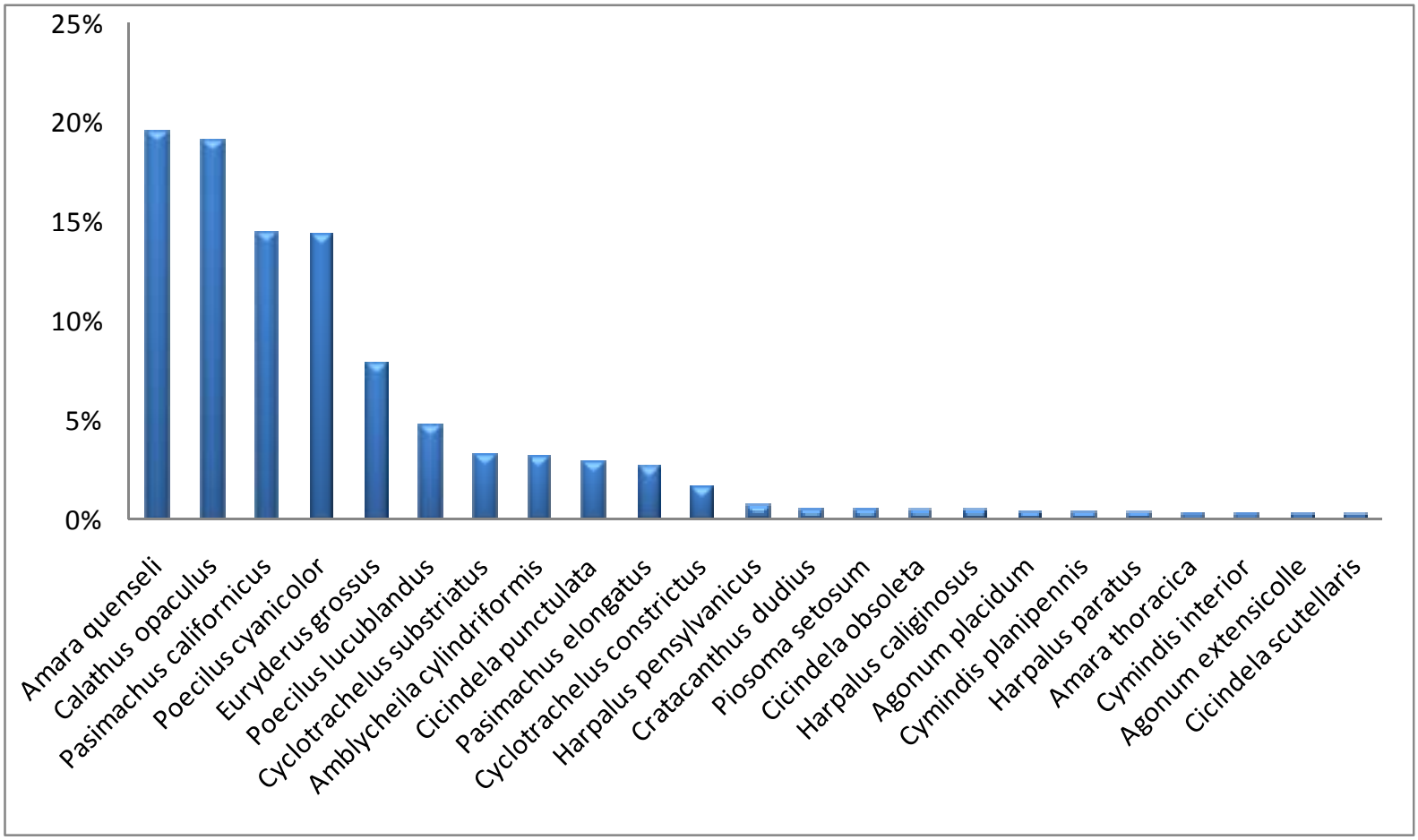

Fig. 17. Carabid species abundance calculated as a proportion of the total abundance of Carabidae for the entire year. Pinon Canyon Maneuver Site, 2007.

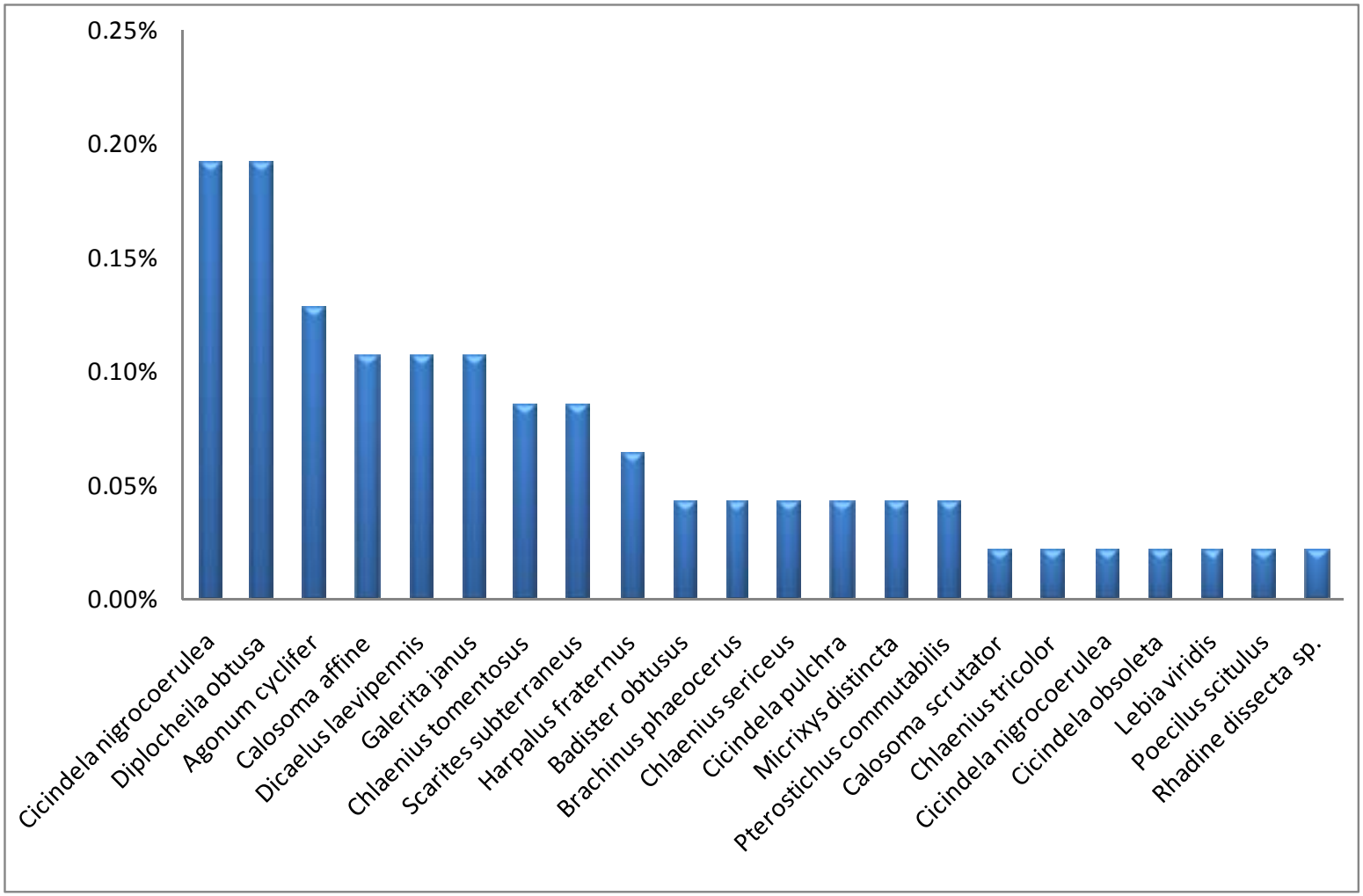

Fig. 18. Carabid species abundance calculated as a proportion of the total abundance of Carabidae for the entire year. Pinon Canyon Maneuver Site, 2007.

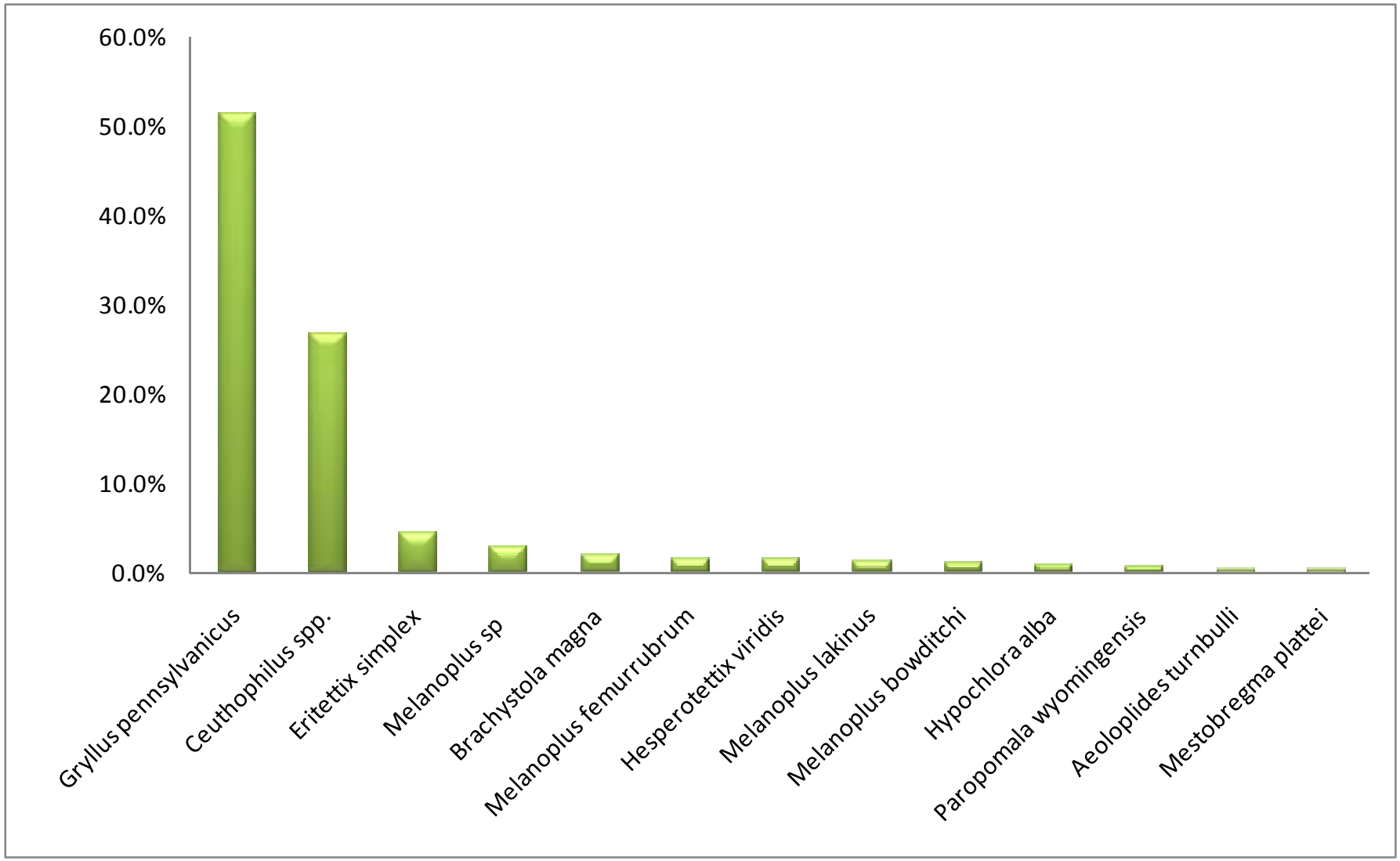

Fig. 19. Orthopteran species abundance calculated as a proportion of the total abundance of Orthoptera for the entire year. Pinon Canyon Maneuver Site, 2007.

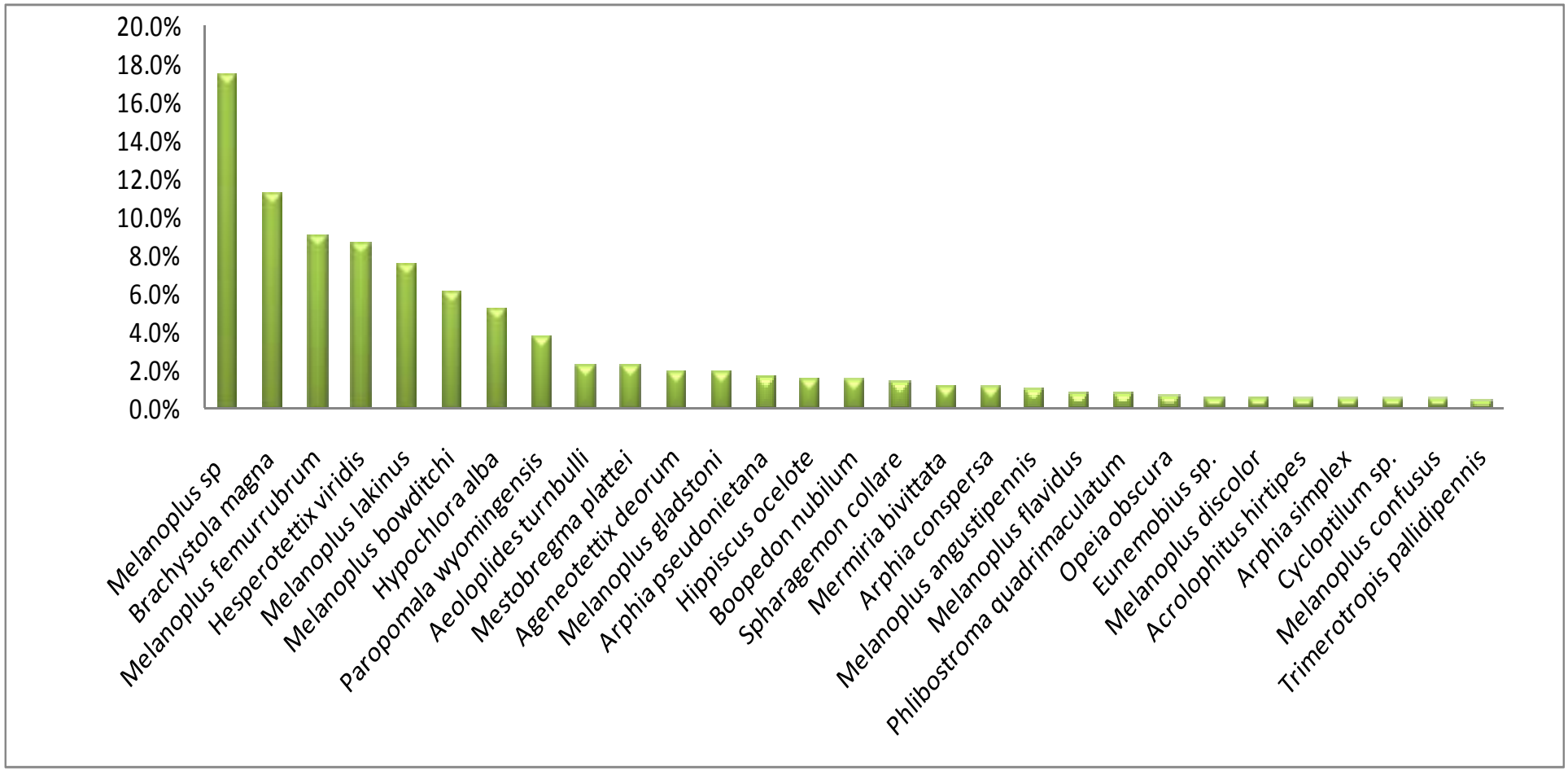

Fig. 20. Acrididae species abundance calculated as a proportion of the total abundance of Acrididae for the entire year. Pinon Canyon Maneuver Site, 2007.

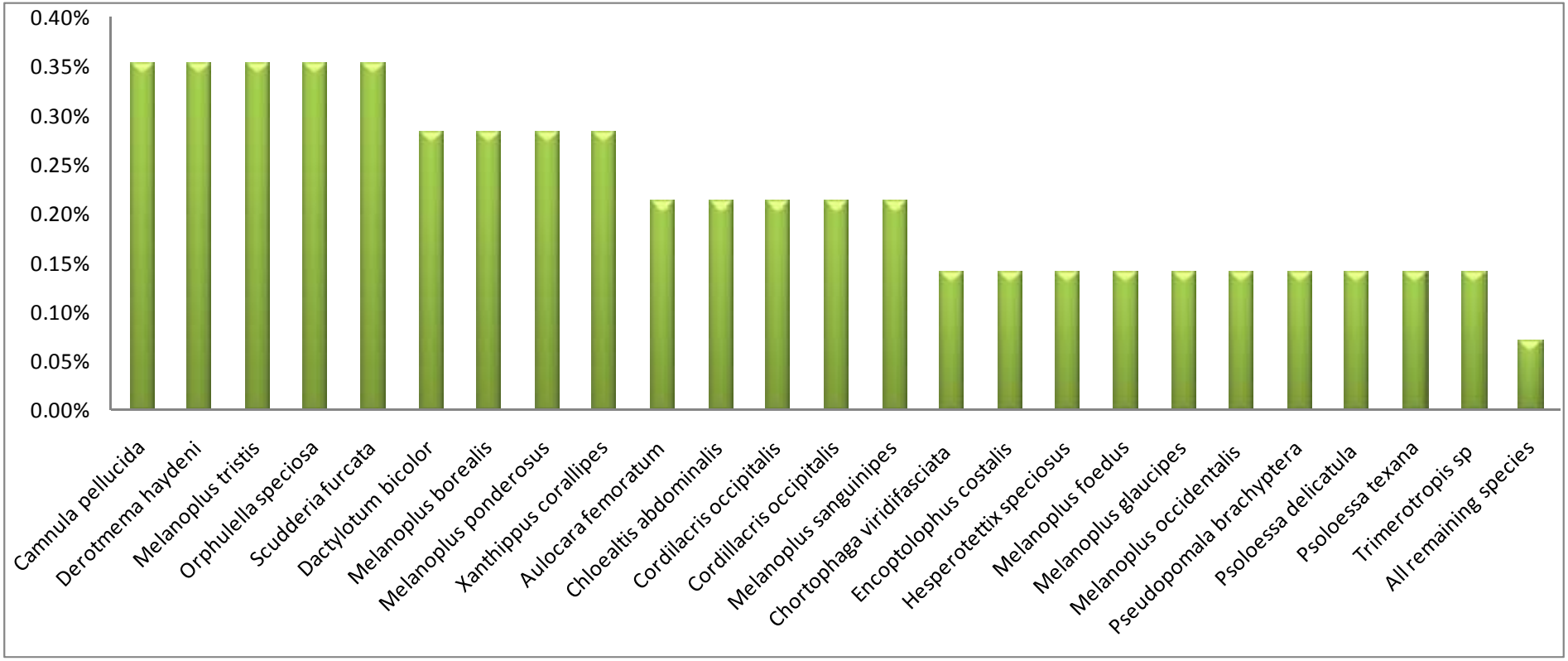

Fig. 21. Acrididae species abundance calculated as a proportion of the total abundance of Acrididae for the entire year. Pinon Canyon Maneuver Site, 2007.

Statistical analyses were performed for each target group. First, to determine which collection method was most effective at collecting each target group, ANOVA was used with collection type as the factor. Butterflies were only collected from the butterfly survey and Carabids were only collected by pitfall trapping, so the analysis was not preformed on them. Significantly more individuals and species of Orthoptera were collected in pitfalls than either malaise traps or sweep-net sampling. Collection method had no effect on the number of individuals or species of ladybeetle collected. Apiformes were more easily collected by malaise than pitfalls, but sweeps collected the same as both pitfalls and malaise. Asilids were collected more using malaise traps than either pitfall or sweep-net sampling, with similar numbers for both pitfall and sweep-net sampling. To reduce the variation due to accidental catch by a method that was not effective, we performed the remaining analyses with the trapping method that yielded the most numbers of individuals. Because no clear technique was found for Apiformes, we analyzed each technique separately.

For further analyses, habitats were placed in one of three categories: Grassland, Shrubland, Woodland, or for pitfall collections TA spp. Total abundance, total species, Shannon's diversity index (H), the evenness of Shannon's diversity index, and a modified Simpson's index was calculated for each target group and collection method for each date and habitat. Each independent factor was compared in a 2-factor ANOVA using date and habitat as factors. Only Asilidae showed a significant interaction of date and habitat. For groups that had no interaction, date and habitat were re-analyzed using each factor independently. For each significant result, LSD post hoc multiple pair wise comparisons were performed to determine which means were different (p=0.05).

One year of data yields a preliminary assessment of the interactions of groups of insects with their environment, but the analyses performed on the 2007 data revealed some interesting distinctions. No differences were observed between habitat or date for Apiformes or Coccinellidae. Asilidae has a significant date and time interaction for all categories analyzed, except the modified Simpson's index. For Asilidae, the grassland has less abundance (Fig. 23a), less species and less diversity according to Shannon's index calculations than either the shrubland or the woodland habitats. There were three peak time periods when Asilids were more abundant, had more species, and higher diversity, except for Simpson's index which was approaching significance (Fig. 22). Orthopteran abundance was significantly lower in the TA spp. habitat than the shrubland and woodland habitats (which were not significantly different), and significantly higher in the grassland habitats. Species abundance, Shannon's index and Simpson's index followed the same pattern. Evenness of Shannon's was approaching significance. Butterflies were only different in the number of species present in a habitat, with the grassland and woodland more had higher species diversity than shrubland (Fig. 23c). Carabids were also only different in the number of species present in habitat, but the grasslands were more had higher species diversity than any other group (Fig. 23d).

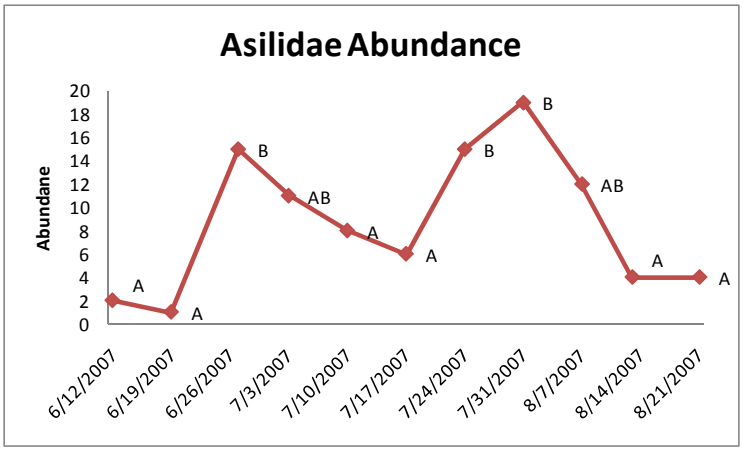

Fig. 22. Peak abundance of Asilidae in Malaise traps. Pinon Canyon Maneuver Site, 2007.

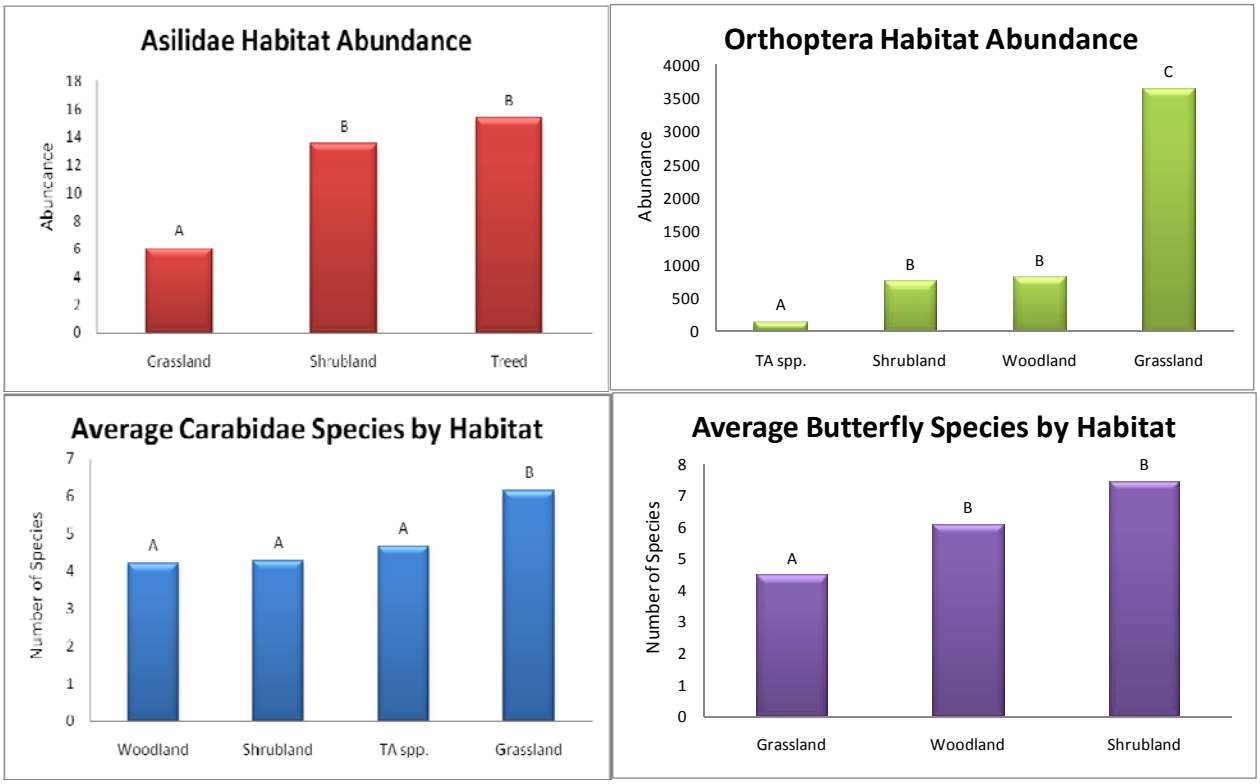

Fig. 23 A-D. A and B represent the total abundance of individuals by habitat. C and D represent the average number of species per habitat over the collection season. Pinon Canyon Maneuver Site 2007.

Discussion

Each collection technique used in 2007 varied in its ability to collect target insects. Few individuals were captured by beat-net and sweep-net sampling, while malaise trap sampling yielded mostly Asilidae and Apiformes. In general, pitfall sampling was the most effective technique for all ground-dwelling insects. Butterfly surveys were very effective for collecting species of butterflies located in each habitat. We have modified the collection protocols for 2008, removing the beat-net and sweep-net sampling and adding surveys for Asilids and Orthoptera. Sweep-net sampling requires more effort in both the field and the lab to collect and process the sample. Many juvenile grasshoppers were collected with this technique which cannot be identified to species. Beat-net samples yielded only 1 target individual for the entire summer. We predict that these modifications will allow us to collect new species in those two target taxa more rapidly than increasing the number of pitfall or malaise traps by selectively collecting insects we observe. Beat-net and sweep-net sampling increased our collection and processing time and produced few results.

The selection of habitats seemed to be proper, with most habitats yielding several species not collected at other sites. The exception was the Ponderosa Pine site that did not yield many individuals (Table 4). Most individuals observed were transient, only passing through the habitat. While we will occasionally collect in the pine habitat, we removed that habitat from routine collections for 2008, to allow time to be spent with the Asilid and Orthoptera surveys in the other habitats. Saltcedar remains a small dense habitat, so pitfall trapping will be the only collection employed there in 2008. All remaining sites will continue to be collected with malaise, pitfall and insect group surveys.

Euphilotes rita, which was observed in the last butterfly survey in August, is listed as G3G4 by the NatureServe. It is listed because some subspecies are very restricted in their range and populations are rare and localized. The species is not currently at risk, but is not viewed as secure. The state conservation status is listed as a S2 which means the species is imperiled in the state. The species is typically located in dry areas with sparse grasses and feeds on *Eriogonum* sp. (Buckwheat) as both larvae and adults. There are two subspecies that occur in Colorado, but lack of a voucher specimen will not allow for determination of the subspecies present at Pinon Canyon (Mattoni 1965).

We observed different use of the habitats by different groups of species. These differences can be used if management of a particular species is required. *Euphilotes rita* is the only species of management concern identified on Pinon Canyon Maneuver Site and the population status of this species cannot be determined based on a single specimen. The habitat differences will allow for better management decisions to be made, if a population of *Euphilotes rita* is determined to be persistent on the base. Until more information can be obtained, no particular management can be recommended at this time for the *Euphilotes rita*.

Conclusions

The Pinon Canyon Maneuver Site is ecologically diverse, and is inhabited by many insect species that tend toward specific habitats. The results presented in this report are from our efforts in one season and therefore are preliminary in nature although useful to lay the basis for a continued study of the area. Being a first-year study form 2007, the report is obviously being published quite a bit after the data was collected. This is due to the amount of time it took to do insect identifications. In 2007 we collected many species that did not play a key part in illustrating potential habitat specificity. Thus, in 2008 we significantly trimmed down the species we collected and modified our collection techniques to make the process more efficient and streamlined.

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Appendix 1: Species list. Pinon Canyon Maneuver Site 2007.

Order Family	Scientific Name	Common Name
Orthoptera (grasshoppers, crickets, katydids)		
Acrididae	*Acrolophitus hirtipes*	Green Fool Grasshopper
	Aeoloplides turnbulli	Russian-Thistle Grasshopper
	Ageneotettix deorum	White-Whiskered Grasshopper
	Amphitornus coloradus	Striped Slantfaced Grasshopper
	Arphia conspersa	Speckle-Winged Rangeland Grasshopper
	Arphia pseudonietana	Northwestern Red-Winged Grasshopper
	Arphia simplex	Plains Yellow-Winged Grasshopper
	Aulocara femoratum	White-Crossed Grasshopper
	Boopedon nubilum	Ebony Grasshopper
	Camnula pellucida	Clear-Winged Grasshopper
	Chloealtis abdominalis	Thomas's Broad-Winged Grasshopper
	Choealtis conspersa	Sprinkled Broad-Winged Grasshopper
	Chorthippus curtipennis	Marsh Meadow Grasshopper
	Chortophaga viridifasciata	Northern Green-Striped Grasshopper
	Circotettix rabula	Wrangler Grasshopper
	Cordillacris crenulata	Crenulated Grasshopper
	Cordillacris sp.	
	Cordillacris occipitalis	Western Spotted-Wing Grasshopper
	Cycloptilum sp	Scaly Cricket
	Dactylotum bicolor	Pictured Grasshopper
	Derotmema haydeni	Hayden's Grasshopper
	Encoptolophus costalis	Dusky Grasshopper
	Eritettix simplex	Velvet-Striped Grasshopper
	Eunemobius sp	Ground Cricket
	Gomphocerinae sp.	Stridulating Slantfaced Grasshopper
	Hadrotettix magnificus	Magnificent Grasshopper
	Hadrotettix trifasciatus	Three-Banded Range Grasshopper
	Hesperotettix speciosus	Western Grass-Green Grasshopper
	Hesperotettix viridis	Meadow Purple-Striped Grasshopper
	Hippiscus ocelote	Wrinkled Grasshopper
	Hippopedon capito	Apache Grasshopper
	Hypochlora alba	Cudweed Grasshopper
	Leprus cyaneus	Blue-Winged Grasshopper
	Listroscelidinae sp.	Predatory Katydid
	Melanoplus sp.	
	Melanoplus borealis	Northern Spur-Throated Grasshopper
	Melanoplus angustipennis	Narrow-Winged Spur-Throated Grasshopper

Order Family	Scientific Name	Common Name
Orthoptera (grasshoppers, crickets, katydids)		
	Melanoplus borealis	Northern Spur-Throated Grasshopper
	Melanoplus bowditchi	Sagebrush Grasshopper
	Melanoplus confusus	Little Pasture Spur-Throated Grasshopper
	Melanoplus discolor	Contrasting Spur-Throated Grasshopper
	Melanoplus dodgei	Dodgei Spur-Throated Grasshopper
	Melanoplus fasciatus	Huckleberry Spur-Throated Grasshopper
	Melanoplus femurrubrum	Red-Legged Grasshopper
	Melanoplus flavidus	Yellowish Spur-Throated Grasshopper
	Melanoplus foedus	Foedus Grasshopper
	Melanoplus gladstoni	Gladston's Spur-Throated Grasshopper
	Melanoplus glaucipes	Glaucous-Legged Spur-Throat
	Melanoplus lakinus	Larkin's Grasshopper
	Melanoplus occidentalis	Flabellate Grasshopper
	Melanoplus packardii	Packard's Grasshopper
	Melanoplus ponderosus	Ponderous Spur-Throated Grasshopper
	Melanoplus regalis	Regal Spur-Throated Grasshopper
	Melanoplus sanguinipes	Migratory Grasshopper
	Melanoplus sp	Spur-Throated Grasshopper
	Melanoplus splendidus	Spur-Throated Grasshopper
	Melanoplus tristis	Spur-Throated Grasshopper
	Melanoplus yarrowii	Yarrow's Spur-Throated Grasshopper
	Mermiria bivittata	Two-Striped Mermiria Grasshopper
	Mermiria picta	Lively Mermiria Grasshopper
	Mestobregma plattei	Platt Range Grasshopper
	Microcentrum sp.	Angle-Wings
	Oedipodinae sp.	Band-Winged Grasshopper
	Opeia obscura	Obscure Grasshopper
	Orphulella speciosa	Pasture Grasshopper
	Pardalophora apiculata	Coral-Winged Grasshopper
	Paropomala wyomingensis	Wyoming Toothpick Grasshopper
	Phlibostroma quadrimaculatum	Four-Spotted Grasshopper
	Phoetaliotes nebrascensis	Large-Headed Grasshopper
	Pseudopomala brachyptera	Short-Winged Toothpick Grasshopper
	Psoloessa delicatula	Brown-Spotted Range Grasshopper
	Psoloessa texana	Texas Spotted Range Grasshopper
	Scudderia furcata	Fork-Tailed Bush Katydids

Order Family	Scientific Name	Common Name
Orthoptera (grasshoppers, crickets, katydids)		
	Spharagemon collare	Mottled Sand Grasshopper
	Spharagemon equale	Say's Grasshopper
	Stethophyma gracile	Graceful Sedge Grasshopper
	Syrbula montezuma	Montezuma's Grasshopper
	Tetrix ornata	Ornate Pygmy Grasshopper
	Trachyrhachys kiowa	Kiowa Rangeland Grasshopper
	Trimerotropis gracilis	Thomas's Slender Grasshopper
	Trimerotropis pallidipennis	Pallid-Winged Grasshopper
	Trimerotropis sp	
	Tropidolophus formosus	Great Crested Grasshopper
	Xanthippus corallipes	Red-Shanked Grasshopper
Gryllidae	*Allonemobius fasciatus*	Striped Ground Cricket
	Gryllus pennsylvanicus	Fall Field Cricket
Oedipodinae	*Encoptolophus costalis*	Dusky Grasshopper
Rhaphidophoridae	*Ceuthophilus*	Camel Cricket
Romaleidae	*Brachystola magna*	Plains Lubber Grasshopper
Tettigoniidae	*Listroscelidinae sp.*	
	Pseudophyllinae sp.	
	Scudderia frucata	Fork-Tailed Bush Katydid
Odonata (dragonflies and damselflies)		
Calopterygidae		Broad-Winged Damselflies
Coenagrionidae		Pond Damselflies
Corduliidae		Emeralds
Gomphidae		Clubtail Dragonflies
Libellulidae	*Libellula pulchella*	Twelve Spotted Skimmer
	Tramea lacerata	Black Saddlebags
Neuroptera		
Chrysopidae		Lacewing
Mantispidae		Mantis Fly
Myrmeleontidae		Antlion
Coleoptera (beetles)		
Anthicidae	*Notoxus* sp.	Ant-Like Flower Beetle
Buprestidae		Metallic Wood Boring Beetles
Cantharidae	*Cantharis* sp.	Soldier Beetles
Carabidae	*Agonum placidum*	Ground Beetle
	Agonum extensicolle	Ground Beetle
	Agonum cyclifer	

Order Family	Scientific Name	Common Name
Carabidae	*Amara quenseli*	Ground Beetle
	Amara thoracica	
	Amblycheila cylindriformis	Great Plains Giant Tiger Beetle
	Badister obtusus	Ground Beetle
	Brachinus phaeocerus	
	Calathus opaculus	Ground Beetle
	Calosoma affine	
	Calosoma scrutator	Ground Beetle
	Calosoma tricolor	
	Chlaenius tricolor	
	Chlaenius sericeus sericeus	Ground Beetle
	Chlaenius tomentosus tomentosus	Ground Beetle
	Cicindela belfragei	Loamy-Ground Tiger Beetle
	Cicindela formosa	Big Sand Tiger Beetle
	Cicindela pulchra	Beautiful Tiger Beetle
	Cicindela scutellaris scutellaris	Festive Tiger Beetle
	Cicindela nigrocoerulea nigrocoerulea	
	Cicindela punctulata punctulata	Punctured Tiger Beetle
	Cicindela obsoleta obsoleta	Large Grassland Tiger Beetle
	Cratacanthus dudius	
	Cyclotrachelus constrictus	
	Cyclotrachelus substriatus	
	Cymindis planipennis	
	Cymindis interior	
	Dicaelus laevipennis laevipennis	
	Diplocheila obtusus	Ground Beetle
	Euryderus grossus	Ground Beetle
	Galerita janus	Ground Beetle
	Harpalus fraternus	
	Harpalus caliginosus	Carabid Beetle
	Harpalus pensylvanicus	Ground Beetle
	Harpalus amputatus	Ground Beetle
	Harpalus paratus	
	Lebia viridis	Ground Beetle
	Micrixys distincta	
	Pasimachus californicus	
	Pasimachus elongatus	Ground Beetle
	Piosoma setosum	

Order Family	Scientific Name	Common Name
Carabidae	*Poecilus cyanicolor*	
	Poecilus lucublandus lucublandus	
	Poecilus scitulus	
	Pterostichus commutabilis	
	Rhadine dissecta sp.	
	Scarites subterraneus	Ground Beetle
Cerambycidae		Long-Horned Wood-Boring Beetles
	Oberea sp.	
Chrysomelidae	*Prionus* sp.	Leaf Beetles
	Calligrapha sp.	
	Diabrotica sp.	
Cleridae		Checkered Flower Beetles
Coccinellidae	*Anatis lecontei*	
	Coccinella septempunctata	Seven-Spotted Ladybeetle
	Hippodamia parenthesis	
	Hippodamia convergens	Convergent Ladybeetle
	Hippopedon capito	
	Myzia interrupta	
Curculiondiae		Weevils
Dytiscidae		Predacious Diving Beetle
Elateridae		Click Beetles
Histeridae		Clown Beetles
Lampyridae		Fireflies
Meloidae	*Epicauta* sp.	Blister Beetles
Nitidulidae	*Carpophilus* sp.	Sap Beetles
Scarabaeidae	*Aphodius* sp.	
	Canthon sp.	Dung Beetle
	Euphoria inda	Bumble Flower Beetle
	Melanocanthon sp.	Dung Beetle
Sciritidae		Marsh Beetles
Silphidae	*Nicrophorus* sp.	Carrion Beetles
	Silpha sp.	
Staphylinidae	*Aleochara* sp.	Rove Beetles
Tenebrionidae	*Diaperis* sp.	Darkling Beetles
	Eleodes sp.	
Trogidae		Hide Beetles

Order Family	Scientific Name	Common Name
Hymenoptera (bees, wasps, ants)		
Apidae	*Apis mellifera*	Honeybee
	Augochlora pura	
	Bombus sp.	Bumblebee
Braconidae		Braconid Wasps
Formicidae		Ants
Halictidae	*Halictini sp.*	
	Halictini (tribe)	
	Halictus sp.	
	Halictus tripartitus	Sweat Bees
	Hylaeus sp.	
	Agapostemon texanus	
Ichneumonidae		Ichneumonid Wasps
Megachilidae	*Megachile sp.*	
	Megachile brevis	Leafcutter or Mason Bees
	Megachile dakotensis	
Mutillidae	*Dasymutilla* sp.	Velvet Ant
Pompilidae	*Pepsis* sp.	Spider Wasps
Sphecidae		Thread-Waisted Wasp
Vespidae	*Polistes* sp.	Paper Wasp
	Vespula sp.	
Diptera (flies)		
Asilidae	*Albibarbefferia albibarbis*	Robber Flies
	Albibarbefferia bicolor	
	Albibarbefferia leucocoma	
	Aridefferia prattii	
	Aridefferia subarida	
	Asilus sp.	
	Asilus auriannulatus	
	Atomosia melanopogon	
	Atomosia nuda	
	Atomosia puella	
	Efferia sp.	
	Efferia anomala	
	Efferia apache	
	Efferia bryanti	
	Efferia duncani	
	Laphystia varipes	

Order Family	Scientific Name	Common Name
Asilidae	*Lasiopogon quadrivittatus*	
	Leptogaster brevicornis	
	Leptogaster weslacensis	
	Ospriocerus abdominalis	
	Philonicus arizonensis	
	Philonicus limpidipennis	
	Proctacanthella exquisita	
	Psilocurus birdi	
	Stichopogon sp.	
Culicidae		Mosquitoes
Muscidae	*Musca domestica*	House Flies
Mydidae	*Mydas* sp.	Mydas Flies
Lepidoptera (butterflies and moths)		
Arctiidae	*Grammia* sp.	Tiger Moths
	Hypoprepia sp.	
Geometridae		Geometer or Geometrid Moths
Hesperiidae	*Amblyscirtes vialis*	Common Roadside-Skipper
	Hesperia pahaska	Pahaska Skipper
	Hesperopsis alpheus	Saltbush Sootywing
	Pholisora catullus	Common Sootywing
	Pyrgus communis	Common Checkered Skipper
	Thorybes pylades	Northern Cloudywing
	Pyrgus scriptura	Small Checkered Skipper
Lycaenidae	*Brephidium exile*	Western Pygmy Blue
	Callophrys gryneus	Juniper Hairstreak
	Euphilotes rita	Rita Dotted Blue
	Hemiargus isola	Reakirt's Blue
	Leptotes marina	Marine Blue
	Plebejus acmon	Acmon Blue
	Plebejus saepiolus	Greenish Blue
	Strymon melinus	Grey Hairstreak
Noctuidae		Millers or Owlet Moths
Nymphalidae	*Anaea andria*	Goatweed Leafwing
	Cercyonis oetus	Small Wood Nymph
	Cercyonis pegala	Common Wood Nymph
	Danaus plexippus	Monarch
	Euptoieta claudia	Variegated Fritillary
	Junonia coenia	Common Buckeye

Order Family	Scientific Name	Common Name
Nymphalidae	*Limenitis archippus*	Viceroy
	Nymphalis antiopa	Mourning Cloak
	Phyciodes campestris	Field Crescent
	Phyciodes mylitta	Mylitta Crescent
	Phyciodes pallida	Pale Crescent
	Phyciodes picta	Painted Crescent
	Phyciodes tharos	Pearl Crescent
	Polygonia interrogationis	Question Mark
	Speyeria coronis	Coronis Fritillary
	Thessalia fulvia	Fulvia Checkerspot
	Vanessa atalanta	Red Admiral
	Vanessa cardui	Painted Lady
	Vanessa virginiensis	American Lady
Papilionidae	*Papilio mulitcaudata*	Two-Tailed Swallowtail
	Papilio polyxenes	Black Swallowtail
	Papilio rutulus	Western Tiger Swallowtail
Pieridae	*Colias cesonia*	Southern Dogface
	Colias eurytheme	Orange Sulphur
	Colias philodice	Clouded Sulphur
	Eurema nicippe	Sleepy Orange
	Nathalis iole	Dainty Sulphur
	Pieris rapae	Cabbage White
	Pontia occidentalis	Western White
	Pontia protodice	Checkered White
Pyralidae		Pyralid Moths
Sphingidae	*Hyles lineata*	White Lined Sphinx
	Proserpinus juanita	

Appendix 2: Presence (black)/Absence (white) in each habitat for each species collected systematically. Pinon Canyon Maneuver Site 2007.

Asilidae									
Scientific Name	ARFI/ YUGL	ATCA/ SPAI	BOGR/ HIJA	GLME/ FRJA	JUMO/ BOER	OPIM/ BOGR	PIPO/ SONU	PODE/ BRJA	TAsp.
Albibarbefferia bicolor					■				
Albibarbefferia leucocoma							■		
Aridefferia prattii					■				
Aridefferia subarida							■	■	
Asilus auriannulatus		■	■						
Atomosia melanopogon				■					
Atomosia nuda		■		■	■	■		■	
Atomosia puella				■					
Laphystia varipes				■					
Lasiopogon quadrivittatus		■							
Leptogaster brevicornis				■					
Leptogaster weslacensis				■					
Ospriocerus abdominalis	■	■			■				
Philonicus arizonensis	■			■				■	
Philonicus limpidipennis	■						■	■	
Proctacanthella exquisita	■	■							
Psilocurus birdi				■					
Stichopogon sp.		■							

Coccinellidae									
Scientific Name	ARFI/ YUGL	ATCA/ SPAI	BOGR/ HIJA	GLME/ FRJA	JUMO/ BOER	OPIM/ BOGR	PIPO/ SONU	PODE/ BRJA	TAsp.
Coccinella septempunctata		■			■			■	
Hippodamia convergens	■	■	■	■	■	■		■	
Hippodamia parenthesis								■	
Myzia interrupta							■	■	

Carabidae									
Scientific Name	ARFI/ YUGL	ATCA/ SPAI	BOGR/ HIJA	GLME/ FRJA	JUMO/ BOER	OPIM/ BOGR	PIPO/ SONU	PODE/ BRJA	TAsp.
Agonum placidum								■	■
Agonum extensicolle								■	
Agonum cyclifer				■				■	■
Amara quenseli	■	■	■	■	■	■		■	■
Amara thoracica				■					
Amblycheila cylindriformis	■	■	■	■	■	■			
Badister obtusus		■							
Brachinus phaeocerus							■	■	
Calathus opaculus	■	■		■	■			■	■
Calosoma affine						■			■
Calosoma scrutator									■
Chlaenius tricolor								■	
Chlaenius sericeus							■	■	
Chlaenius tomentosus	■								
Cicindela pulchra						■			
Cicindela nigrocoerulea				■					
Cicindela obsoleta						■			
Cicindela nigrocoerulea		■		■		■			
Cicindela obsoleta				■	■	■			
Cicindela punctulata	■	■	■			■	■	■	
Cicindela scutellaris	■								
Cratacanthus dubius	■		■	■		■			
Cyclotrachelus constrictus	■		■						
Cyclotrachelus substriatus	■	■	■	■	■	■		■	
Cymindis planipennis	■		■		■			■	
Cymindis interior	■		■						
Dicaelus laevipennis		■		■	■				

Carabidae									
Scientific Name	ARFI/ YUGL	ATCA/ SPAI	BOGR/ HIJA	GLME/ FRJA	JUMO/ BOER	OPIM/ BOGR	PIPO/ SONU	PODE/ BRJA	TAsp.
Diplocheila obtusa		■		■					
Euryderus grossus	■								
Galerita janus								■	■
Harpalus fraternus									■
Harpalus caliginosus	■	■	■			■			
Harpalus paratus	■			■		■			■
Harpalus pensylvanicus	■		■			■		■	■
Lebia viridis								■	
Micrixys distincta		■						■	
Pasimachus californicus	■	■	■	■	■	■		■	■
Pasimachus elongatus	■	■	■	■	■	■		■	■
Piosoma setosum			■			■			■
Poecilus cyanicolor		■		■		■		■	
Poecilus lucublandus								■	
Poecilus scitulus						■			
Pterostichus commutabilis								■	
Rhadine dissecta sp.	■								
Scarites subterraneus								■	

Lepidoptera- Butterflies and Skippers									
Scientific Name	ARFI/ YUGL	ATCA/ SPAI	BOGR/ HIJA	GLME/ FRJA	JUMO/ BOER	OPIM/ BOGR	PIPO/ SONU	PODE/ BRJA	TAsp.
Amblyscirtes vialis	■	■							
Anaea andria			■					■	
Brephidium exile		■	■	■	■				
Cercyonis pegala		■			■			■	
Colias cesonia				■				■	
Colias euytheme	■	■	■	■	■	■		■	
Colias philodice	■	■	■	■	■	■	■	■	
Danaus plexippus	■	■		■	■	■		■	
Euphilotes rita	■								
Euptoieta claudia	■	■	■	■	■	■	■	■	
Eurema nicippe								■	
Hemiargus isola	■				■			■	
Hesperia pahaska					■				
Hesperopsis alpheus		■			■				
Leptotes marina								■	
Limenitis archippus					■			■	
Nathalis iole	■	■	■	■	■	■	■	■	
Nymphalis antiopa							■	■	
Papilio mulicaudata								■	
Papilio multicaudata		■			■		■	■	
Papilio polyxenes	■					■	■		
Papilio rutulus					■				
Pholisora catullus	■	■		■					
Phyciodes campestris				■					
Phyciodes pallida	■			■				■	
Phyciodes picta	■	■	■	■		■	■	■	
Phyciodes tharos		■		■	■			■	

Lepidoptera- Butterflies and Skippers									
Scientific Name	ARFI/ YUGL	ATCA/ SPAI	BOGR/ HIJA	GLME/ FRJA	JUMO/ BOER	OPIM/ BOGR	PIPO/ SONU	PODE/ BRJA	TAsp.
Pieris rapae	■	■		■	■	■	■	■	
Plebejus acmon							■		
Plebejus saepiolus		■							
Polygonia interrogationis								■	
Pontia occidentalis					■				
Pontia protodice	■	■	■	■	■	■	■	■	
Pyrgus communis	■	■	■	■	■	■	■	■	
Pyrgus scriptura								■	
Speyeria coronis	■				■				
Strymon melinus	■	■	■	■	■	■	■	■	
Thessalia fulvia							■		
Thorybes pylades				■					

Hymenoptera									
Scientific Name	ARFI/ YUGL	ATCA/ SPAI	BOGR/ HIJA	GLME/ FRJA	JUMO/ BOER	OPIM/ BOGR	PIPO/ SONU	PODE/ BRJA	TAsp.
Agapostemon texanus	■		■	■					
Apis mellifera		■				■			
Augochlora pura	■	■	■			■		■	
Halictini sp.								■	
Halictus sp.	■	■			■			■	
Halictus tripartitus	■	■	■	■	■	■		■	■
Hylaeus sp.	■								
Megachile brevis				■	■				■
Megachile dakotensis						■			
Megachile sp.	■	■	■		■			■	■

Orthoptera									
Scientific Name	ARFI/ YUGL	ATCA/ SPAI	BOGR/ HIJA	GLME/ FRJA	JUMO/ BOER	OPIM/ BOGR	PIPO/ SONU	PODE/ BRJA	TAsp.
Acrolophitus hirtipes	■		■						
Aeoloplides turnbulli		■	■	■	■	■			
Ageneotettix deorum	■	■	■	■	■	■			
Amphitornus coloradus	■								
Arphia conspersa	■	■	■		■				
Arphia pseudonietana	■	■	■		■	■			■
Arphia simplex	■	■	■		■				
Aulocara femoratum			■			■			
Boopedon nubilum	■					■			
Brachystola magna	■		■		■	■			
Camnula pellucida		■	■			■			
Ceuthophilus sp.	■	■	■	■	■	■		■	■
Chloealtis abdominalis		■				■			
Choealtis conspersa					■				
Chorthippus curtipennis					■				
Chortophaga viridifasciata								■	
Circotettix rabula					■				
Cordillacris sp.	■								
Cordillacris crenulata						■			
Cordillacris occipitalis	■		■			■			
Cycloptilum sp.					■				
Dactylotum bicolor	■			■		■			
Derotmema haydeni	■		■						
Encoptolophus costalis				■		■			
Eritettix simplex	■	■	■	■	■	■		■	
Eunemobius sp.				■		■			■
Gomphocerinae sp.	■								

Orthoptera									
Scientific Name	ARFI/ YUGL	ATCA/ SPAI	BOGR/ HIJA	GLME/ FRJA	JUMO/ BOER	OPIM/ BOGR	PIPO/ SONU	PODE/ BRJA	TAsp.
Gryllus pennsylvanicus	■	■	■	■	■	■		■	■
Hadrotettix trifasciatus	■								
Hesperotettix speciosus		■							
Hesperotettix viridis	■	■	■	■	■	■			
Hippiscus ocelote	■		■	■		■			
Hippopedon capito					■				
Hypochlora alba	■				■	■			
Leprus cyaneus				■					
Malanoplus borealis	■	■	■						
Melanoplus angustipennis	■	■			■	■			
Melanoplus borealis					■				
Melanoplus bowditchi	■	■	■	■	■	■			
Melanoplus confusus	■		■			■			
Melanoplus discolor	■	■	■	■	■	■			
Melanoplus dodgei	■								
Melanoplus fasciatus	■								
Melanoplus femurrubrum	■	■	■	■	■	■		■	■
Melanoplus flavidus	■					■			
Melanoplus foedus		■							
Melanoplus gladstoni	■	■	■	■	■	■		■	
Melanoplus glaucipes			■					■	
Melanoplus lakinus	■	■	■	■	■	■	■	■	■
Melanoplus occidentalis			■					■	
Melanoplus packardii			■						
Melanoplus ponderosus	■		■						
Melanoplus regalis		■							
Melanoplus sanguinipes	■					■			

Orthoptera									
Scientific Name	ARFI/ YUGL	ATCA/ SPAI	BOGR/ HIJA	GLME/ FRJA	JUMO/ BOER	OPIM/ BOGR	PIPO/ SONU	PODE/ BRJA	TAsp.
Melanoplus sp	■	■	■	■	■	■	■		■
Melanoplus splendidus	■				■				
Melanoplus tristis	■	■							
Melanoplus yarrowii					■				
Mermiria bivittata	■	■	■	■	■	■			■
Mermiria picta						■			
Mestobregma plattei	■				■	■			
Microcentrum sp.				■					
Oedipodinae sp.						■			
Opeia obscura	■	■	■	■		■			
Orphulella speciosa	■	■	■	■	■				■
Pardalophora apiculata								■	
Paropomala wyomingensis	■	■	■		■	■			
Phlibostroma quadrimaculatum	■		■		■				
Phoetaliotes nebrascensis					■				
Pseudopomala brachyptera	■								
Psoloessa delicatula	■	■							
Psoloessa texana	■				■				
Scudderia furcata	■								
Spharagemon collare	■		■			■		■	
Spharagemon equale	■								
Stethophyma gracile	■								
Syrbula montezuma	■								
Tetrix ornata				■					
Tettiqoniidae listroscelidinas									■
Tettiqoniidae pseudophyllinae						■			
Trachyrhachys kiowa	■								

Orthoptera									
Scientific Name	ARFI/ YUGL	ATCA/ SPAI	BOGR/ HIJA	GLME/ FRJA	JUMO/ BOER	OPIM/ BOGR	PIPO/ SONU	PODE/ BRJA	TAsp.
Trimerotropis magnifica	■								
Trimerotropis pallidipennis	■				■				
Trimerotropis sp	■				■				
Xanthippus corallipes	■			■					