

Long-Term Studies of Ground-Dwelling Arthropod
Biodiversity at Bandelier National Monument

Data for 2013

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Introduction

This annual report summarizes recent results of an on-going long-term monitoring study of ground-dwelling arthropods at Bandelier National Monument that was initiated in 1992 by David Lightfoot and Craig Allen. Sandra Brantley joined the project in 1997. Mark Ward's participation commenced with the 2013 samples. Interannual variation in abundance is notoriously high in arthropod populations so that long-term monitoring is necessary to detect changes that may be due to climate or land use shifts. Studies of mountain ground-dwelling arthropods in the U.S. have been few, especially at the community level. The Bandelier study was designed to describe patterns of these communities across an elevational gradient and to associate those changes with large-scale weather patterns, such as El Niño Southern Oscillation (ENSO), which has a strong impact on the southwestern U.S. From long-term study we gain baseline data to compare with responses to abnormally dry (La Niña) or wet (El Niño) years and to detect possible time lags in responses.

In areas with high topographic variation, such as the southwestern U.S., mountains provide elevational gradients without change in latitude, so that elevation effect may be studied more clearly. The gradient extends from lower elevations, which are dry and warm, to high elevations, which are cooler and receive more precipitation. These abiotic differences produce obvious changes in plant species and cover. The ENSO cycle can be thought of as a natural "treatment" applied across the gradient.

If arthropods respond over a short period to ENSO events, we expect to see one of two likely patterns. The first is that lowland species would be less affected by drought conditions because they already live at the dry end of the gradient. Species at high elevations, which generally do not experience dry conditions, might be more strongly and negatively affected. The second is that lowland species may experience more negative conditions when their habitats become even drier, while montane species are more buffered against the severity of the drought. The purpose of our research project was to determine if data on a group of organisms living across such an elevational gradient supported one of the above predictions, or perhaps some other pattern.

Methods

This research was conducted at Bandelier National Monument, in the Jemez Mountains of north-central New Mexico. Three study sites were established across an elevation gradient from approximately 6000 ft elevation at the base of the mountains, to approximately 9500 ft elevation near the summits of the mountains. Piñon pine (*Pinus edulis*) and one-seed juniper (*Juniperus monosperma*) made up the dominant vegetation at the low-elevation site (PJ), ponderosa pine (*Pinus ponderosa*) was dominant at the mid-elevation site (PP) and several mixed conifer species, such as Douglas-fir (*Pseudotsuga menziesii*), Engelmann spruce (*Picea engelmannii*), white fir (*Abies concolor*), ponderosa pine and quaking aspen (*Populus tremuloides*), dominated at the high-elevation site (MC).

Permanent pitfall traps capture ground-dwelling arthropods, gathering information on species composition and relative abundance at a site in each of the three elevation zones. Five replicate sets of traps were located at each of the three sites. Each of the five sets of traps consisted of six individual replicate traps positioned in a line, approximately 5 m apart, for a total of 30 traps at each site. (An additional mixed-conifer site, Site F, was established in 1993, in a prescribed burn area to examine the effects of fire on the population of the Jemez Mountain salamander.) The replicate lines were placed at least 200 m apart. Each trap consisted of a steel can 8 cm in diameter buried in the ground with the can opening even with the ground. A plastic cup half full of propylene glycol was placed in each can and a small wooden cover was positioned about 5 cm above each trap for protection from sunlight and precipitation. All traps were left open continuously year-round. Arthropods were collected from all of the traps in April, June, August and October. Trap samples were sorted and tabulated to the species level. All data were pooled for a given year.

Only arthropod taxa that are known to be ground-surface active, appropriately sampled by pitfall traps, were tabulated. Other taxa that are not appropriately sampled by pitfall traps were not tabulated. Of the target taxa, only those groups that were represented by large numbers of individuals were used for analysis. Those taxonomic groups included the following: spiders (Araneae; predators), darkling beetles (Coleoptera: Tenebrionidae; detritivores), ground beetles (Coleoptera: Carabidae; predators), centipedes (Chilopoda; predators), and millipedes (Diplopoda; detritivores).

Samples were sorted, and target taxa identified and counted for each trap. Sandra Brantley identified and counted non-insect target and Mark Ward identified and counted insect target taxa. The data were entered into a Microsoft Excel file included with this report, along with selected data from 1992-2012 for comparison.

Seasonal data were presented until the 2000 report, when the data set became too large, so that only annual data could be shown. The species list for all target taxa is included as Appendix 1. Several taxonomic changes have occurred over the course of this study; current names are linked to old ones in the species list (Appendix 1). The major sources we used for determining current taxonomic status included: 1) Ross Arnett, *American Insects*, 2) Entomological Information Service, *Nomina Insecta Nearctica*, 3) World Spider Catalog and 4) original descriptive literature and correspondence with expert taxonomists. We continue to work on reconciling species names across the annual datasets. In some cases species names have changed, and in others we now have names where we formerly had only morphospecies numbers. This process will allow us to better compare richness patterns over the years.

Results

This was the second collection year after the Las Conchas fire. The Las Conchas wildfire (June 26-August 3, 2011) burned large portions of Bandelier National Monument and the Valles Caldera National Preserve. The fire damaged the ponderosa pine and mixed-conifer pitfall sites but not the piñon-juniper site. The Las Conchas wildfire was the second wildfire that has burned through some of the study sites since they were established in 1992. A summary of documented wildfire severity at all mixed-conifer and ponderosa pine sites dating back to the La Mesa wildfire of 1977 is included (Table 1). Piñon-juniper sites were not burned by any of these wildfires.

Table 1. A history of wildfire severity at pitfall transect lines in the forests of the Jemez Mountains, New Mexico dating back to the most recent wildfire preceding study implementation (1977-present).

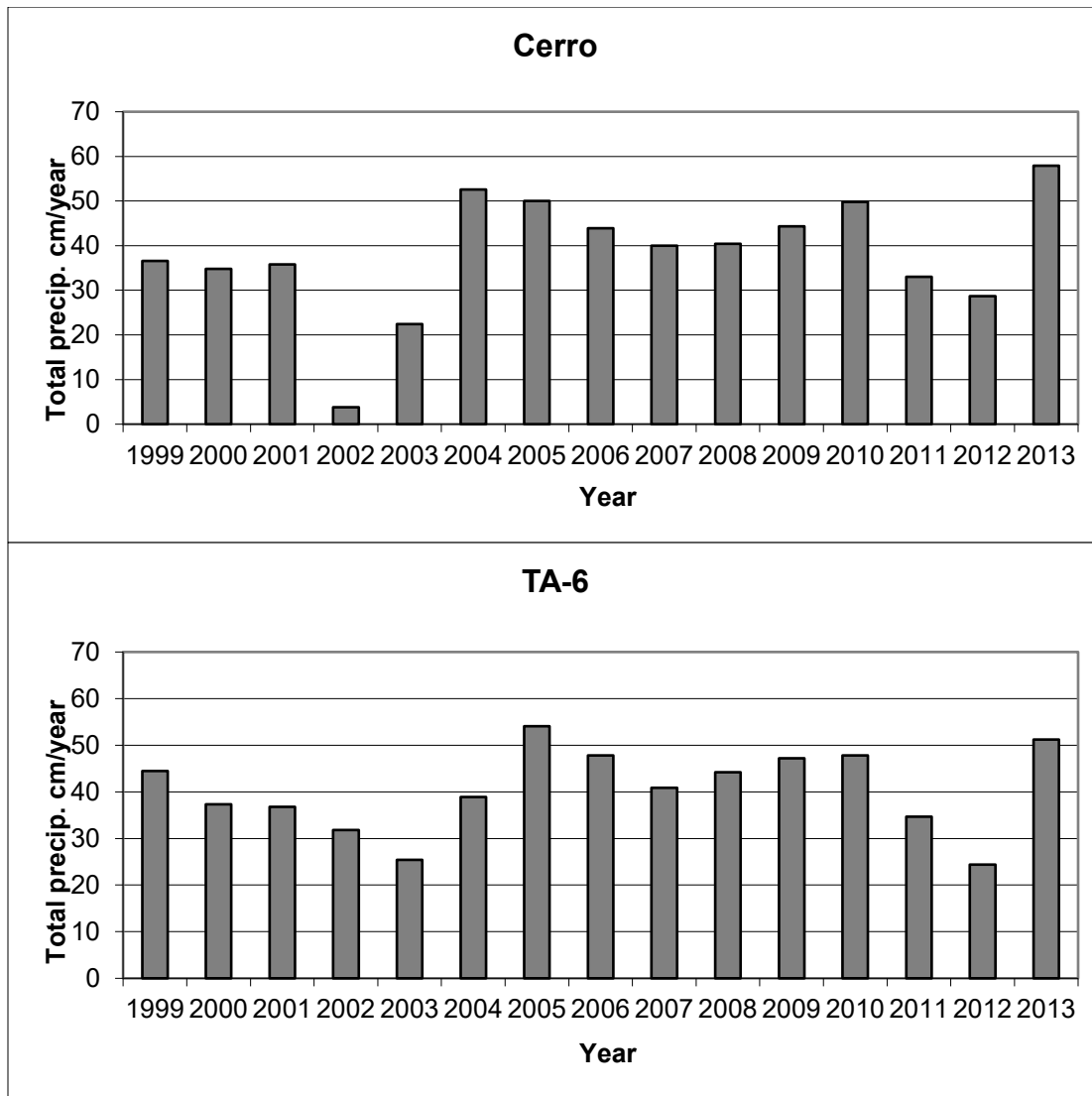
Habitat-Transect Line	La Mesa (1977)	Cerro Grande (2000)	Las Conchas (2011)
MC-A	0	mod	0
MC-B	0	0	high
MC-C	0	0	low
MC-D	0	low	low
MC-E	0	0	mod
MC-F	0	0	high
PP-A	Low	0	high
PP-B	Low	0	mod
PP-C	Low	0	low
PP-D	Low	0	low
PP-E	Low	0	low
PP-RG	High	0	mod

Precipitation

Weather data for 1999-2013 were available from the three elevations of interest: Firetower TA-16, representing piñon-juniper at 6500 ft., Los Alamos TA-6 Tower, representing ponderosa pine at 7424 ft., and Cerro, representing mixed-conifer at

9160 ft. (Fig. 1). Annual precipitation levels in 2013 were higher than either of the two previous dry years at all elevations. Total annual precipitation amounts were more akin to those received in years 2006-2010, although slightly higher in mixed conifer forest than amounts received during this time period. The 2013 monthly totals for the Bandelier weather stations showed very little precipitation between January and July; rain from July to September accounted for >50% of annual precipitation at all three elevations. Especially noteworthy were unusually high precipitation totals for the month of September alone accounting for nearly 50% of the annual precipitation at all three elevations: 53% (PJ), 43% (PP) and 45% (MC).

Weather data for the years before 1999 came from different locations and are contained in earlier annual reports. We thank Kay Beeley for compiling the precipitation data and for coordinating the collection of the pitfall traps.



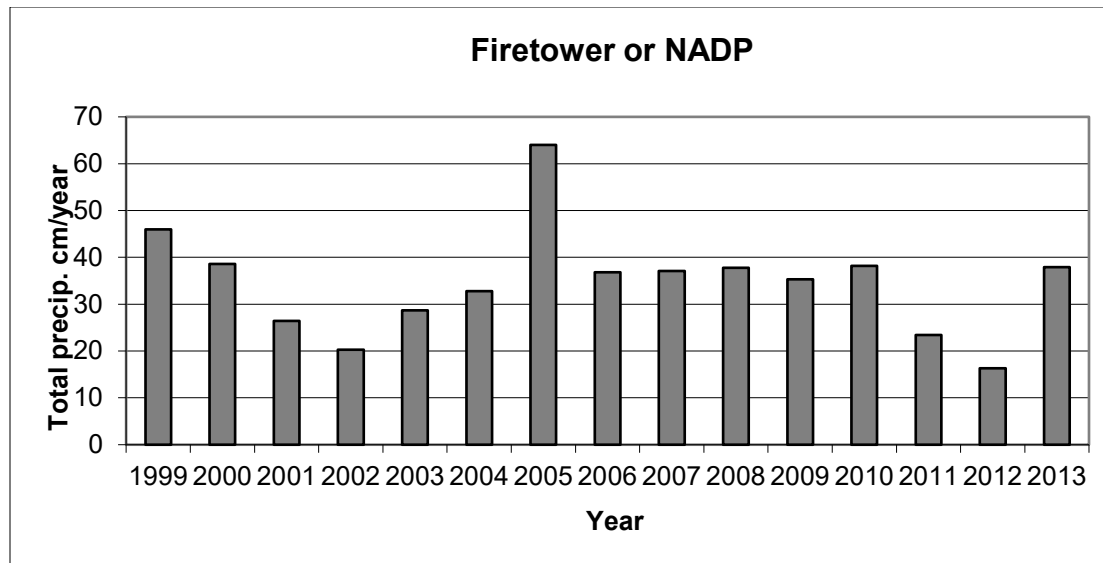


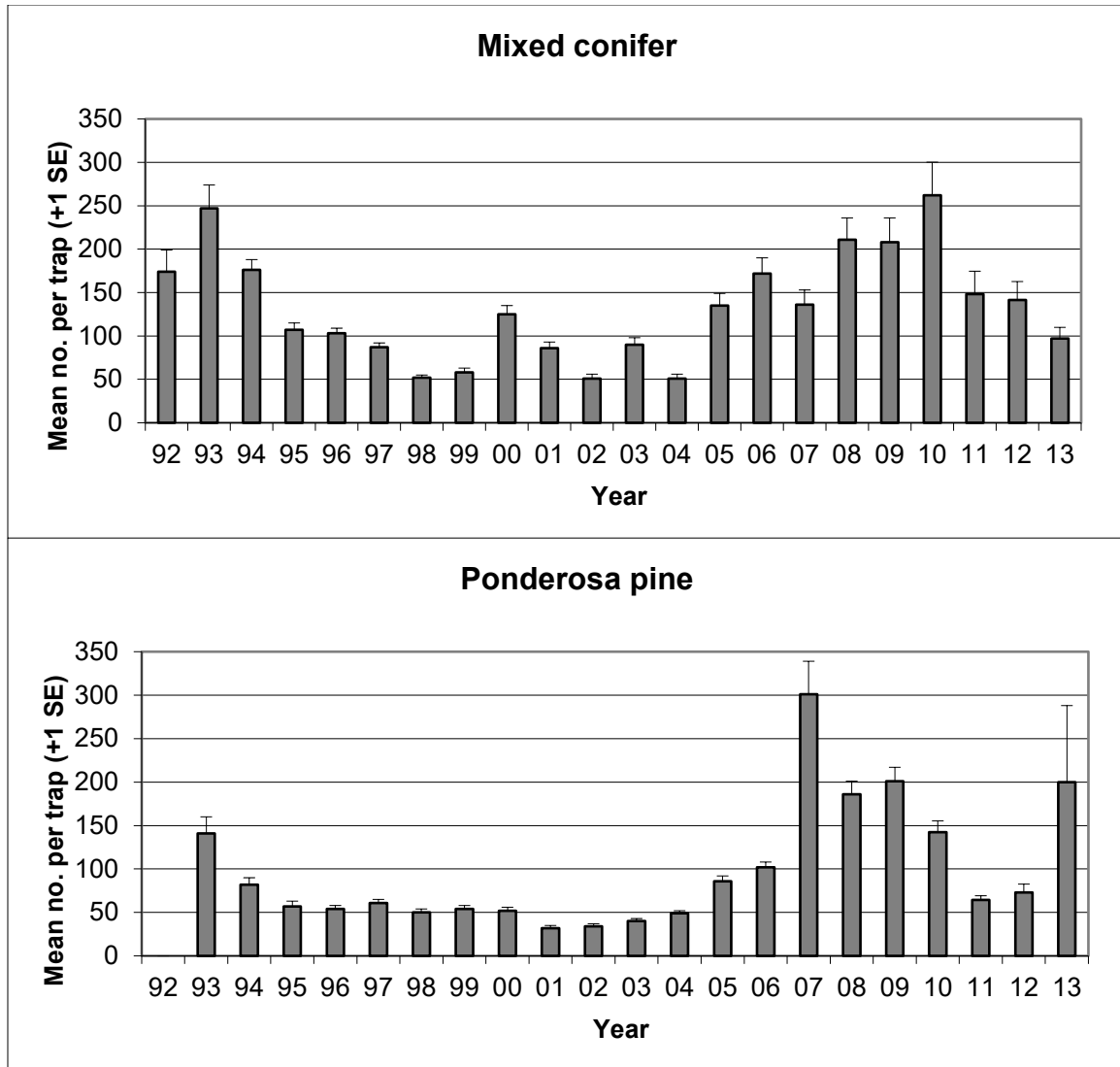
Fig. 1. Bandelier precipitation.

Ground-dwelling Arthropods

Arthropod abundances were high when this study began in 1992, an El Niño year (Fig. 2). Numbers declined at all sites in the drought of 1994-1995 and stayed low through 2002. In 2003 numbers increased for most of the dominant species and declined again in 2004, and then rose sharply in 2005 (Table 1, Figs. 2, 4-10). In 2005 the PJ site received the most precipitation since this project began (Fig. 1). Arthropod numbers there were higher than in the other 2 sites during every collecting period; half of the relative abundance came from this site alone, suggesting that the PJ site is generally under marginal conditions and susceptible to drought, but that arthropods can respond quickly under periods of high precipitation. Abundance at all sites continued to be high from 2006-09, approaching that of the series of strong El Niño years of the early 1990's. In 2010 numbers started to decline at PJ and PP, but not at MC. In 2011 abundance declined at all sites: at PJ probably because of the drought, and at PP and MC because of the combined drought and fire. Abundance continued to decline in both 2012 and 2013 at MC sites possibly because of lingering Las Conchas fire effects. Abundance in both PJ and PP sites increased in 2012 and 2013. Abundance in PP sites appeared to dramatically increase in 2013 though with a very high standard error. Whether the increased abundance at PP is associated with changes in the soil surface following the fire that may have made it easier for ground-dwelling species to move across it is unclear.

Arthropod richness fluctuates less than abundance from year to year but did increase during 2006-2007 and has since declined a little (Fig. 3). In 2011 richness declined, probably as a combination of drought and the fire, but increased slightly in 2012 at PP and MC. Richness declined slightly at PJ. Not every species was collected every year, making long-term studies of particular importance in characterizing the biodiversity at the sites. While richness and abundance fluctuated seasonally and annually, the dominant species tended to

remain dominant. Species are well known to respond independently to environmental factors, so that responses of one species are not necessarily indicative of the responses of others (Table 2; compare Figs. 4-10). It is also important to note that each El Niño / La Niña event is unique in its pattern across the state. For example, the El Niño of 1992-1994 influenced arthropod abundance (at least in part) to an extent that has not been seen again until 2005-09, including the 1997-1998 El Niño. Table 2 below compares 2007-2013 for total numbers of arthropods collected (relative abundance) and the numbers collected for the most abundant species.



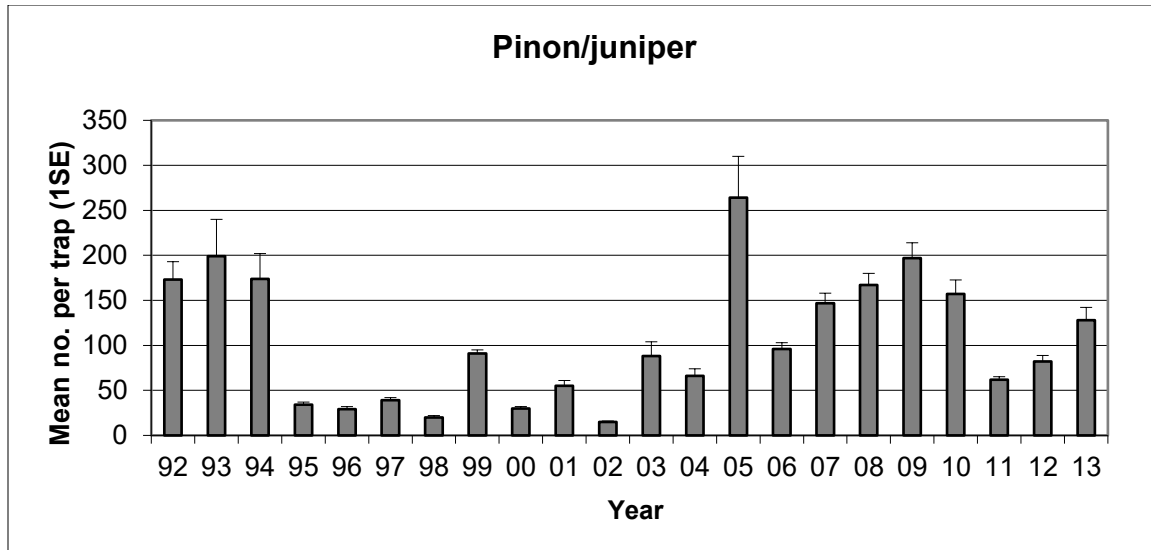


Fig. 2. Mean arthropod relative abundance by site and year.

Taxon richness fluctuates less than abundance from year to year but did increase during 2006-2007 and has since declined a little (Fig. 3). In 2011 richness declined, probably as a combination of drought and the fire, and has stayed slightly below the 2006-2007 levels at all elevations in 2012 & 2013. Not every species was collected every year, making long-term studies of particular importance in characterizing the biodiversity at the sites. While richness and abundance fluctuated seasonally and annually, the dominant species tended to remain dominant. Species are well known to respond independently to environmental factors, so that responses of one species are not necessarily indicative of the responses of others (Table 2; compare Figs. 4-10). It is also important to note that each El Niño / La Niña event is unique in its pattern across the state. For example, the El Niño of 1992-1994 influenced arthropod abundance (at least in part) to an extent that has not been seen again until 2005-09, including the 1997-1998 El Niño. Table 2 below compares 2007-2013 for total numbers of arthropods collected (relative abundance) and the numbers collected for the most abundant species. The total number of arthropods collected in 2013 was greater than in either of the two previous years, but for some of the most abundant species numbers were down in 2013 when compared to the two previous years (Table 2).

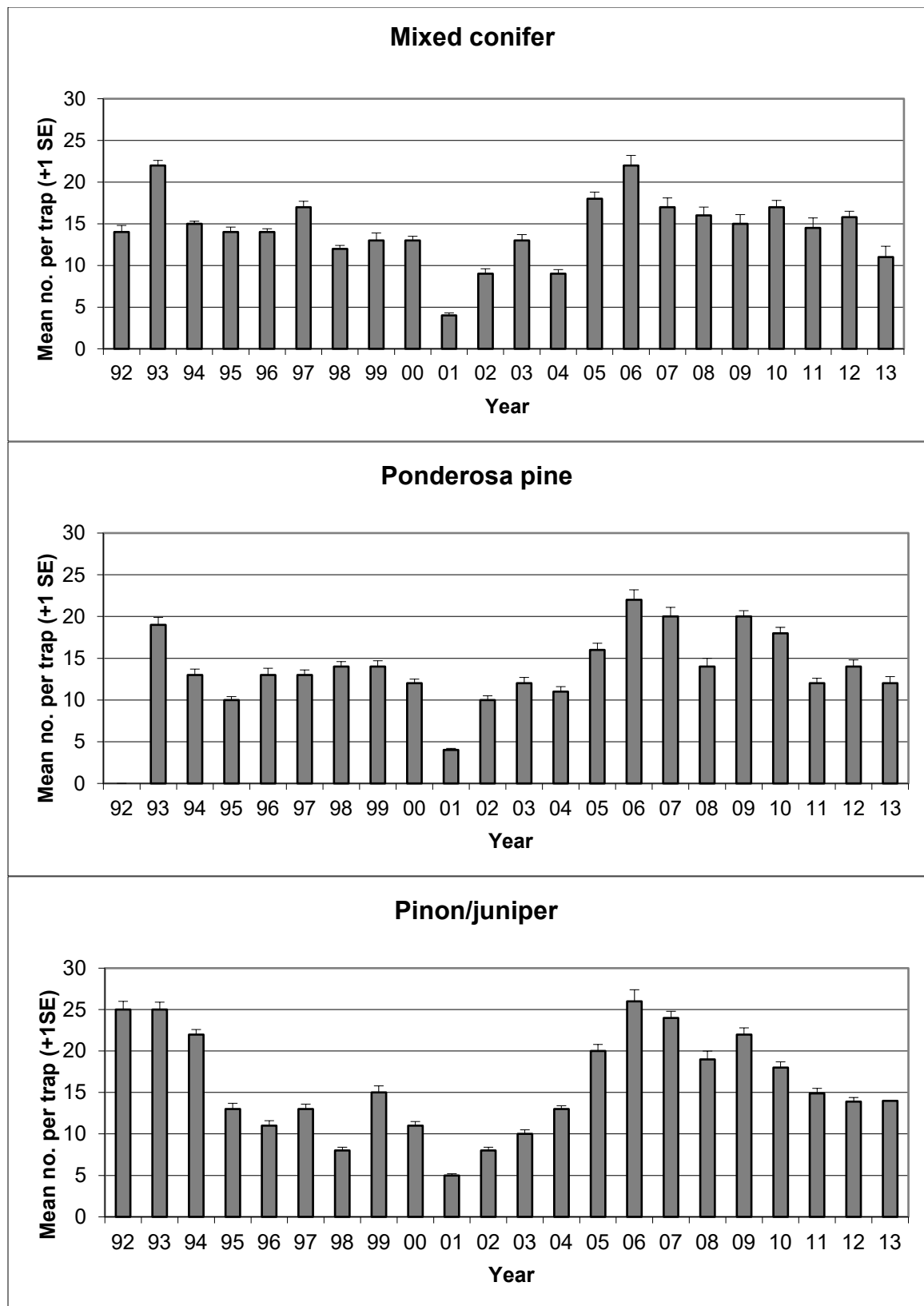


Fig. 3. Mean arthropod species richness by site and year.

Table 2. Comparison of relative abundance for selected species at the study sites.

Taxon	Relative Abund. 2007	Relative Abund. 2008	Relative Abund. 2009	Relative Abund. 2010	Relative Abund. 2011	Relative Abund. 2012	Relative Abund. 2013
All species	20,603	19,124	21,040	19,906	9549	10,309	17,780
<i>Oriulus venustus</i> (millipede)	23	23	46	38	79	18	14
<i>Pardosa uncata</i> (wolf spider)	244	387	407	349	165	190	491
<i>Togwoteeus biceps</i> (harvestman)	702	571	1285	1500	393	335	140
<i>Trachyrhinus marmoratus</i> (harvestman)	125	77	110	150	11	2	0
<i>Carabus taedatus</i> (ground beetle)	65	92	125	306	96	190	47
<i>Machilinus aurantiacus</i> (bristletail)	1014	1702	1735	1698	61	274	241
<i>Ceuthophilus pallidus</i> (camel cricket)	429	219	158	269	138	407	378
<i>Ceuthophilus utahensis</i> (camel cricket)	2078	3015	5150	6953	3291	2539	1448
<i>Pterostichus adstrictus</i> (ground beetle)	8005	1054	220	321	52	283	80
<i>Eleodes extricatus</i> (darkling beetle)	621	746	500	545	410	280	229
<i>Eleodes obscurus</i> (darkling beetle)	367	436	1049	638	379	150	94

Table 3. Total numbers of target taxa collected by site and season for 2013.

Collecting period	Piñon-juniper site	Ponderosa pine site	Mixed conifer site	Total
Oct12-Apr 13	1167	1215	763	3145
Apr 13-Jun 13	1244	4095	2474	7813
Jun 13-Aug 13	1152	2241	1323	4716
Aug 13-Oct 13	1131	608	367	2106
Total	4694	8159	4927	17780

Spiders were widely distributed throughout the sites (Fig. 4), with high abundance during the El Niño years of the early 1990's. Their numbers fell sharply during the drought of the mid-1990's and did not recover until 2005-2009 and started to decline in 2010. The El Niño of 1997-1998 was not a strong one for New Mexico and produced little effect on the spiders at the PJ and PP sites, but probably did influence the abundance seen at the MC site. Most of the abundance at MC comes from wolf spiders (Lycosidae), especially *Pardosa uncata* and *P. yavapa* and the small-bodied linyphiid sheet weavers. Ground spiders (Gnaphosidae) dominate at PP, while a different wolf spider, *Schizocosa mccooki*, dominates at PJ. The wolf spider *P. orophila* virtually disappeared from the PJ site during the mid-1990's through 2004, but has been collected again in low numbers from 2005-2010 (numbers fell from 30 in 2009 to 7 in 2010 to 4 in 2011 PP, to 1 each in PJ and PP in 2012 to none in 2013). At the PP site, the vegetation overstory had increased in the last several years, especially in the RG part, until the Las Conchas fire burned the trees back again. Spiders are often active during the winter and in 2010 made up 53% of the arthropods collected in the April samples, and 33% of the April 2011 samples. This collection was made before the fire and shows the drop was probably due to lack of precipitation in late winter and spring. Spiders made up 36% of the April 2012 total. Spider numbers were up at all habitats for the year in 2013, and made up 30% of the April 2013 samples.

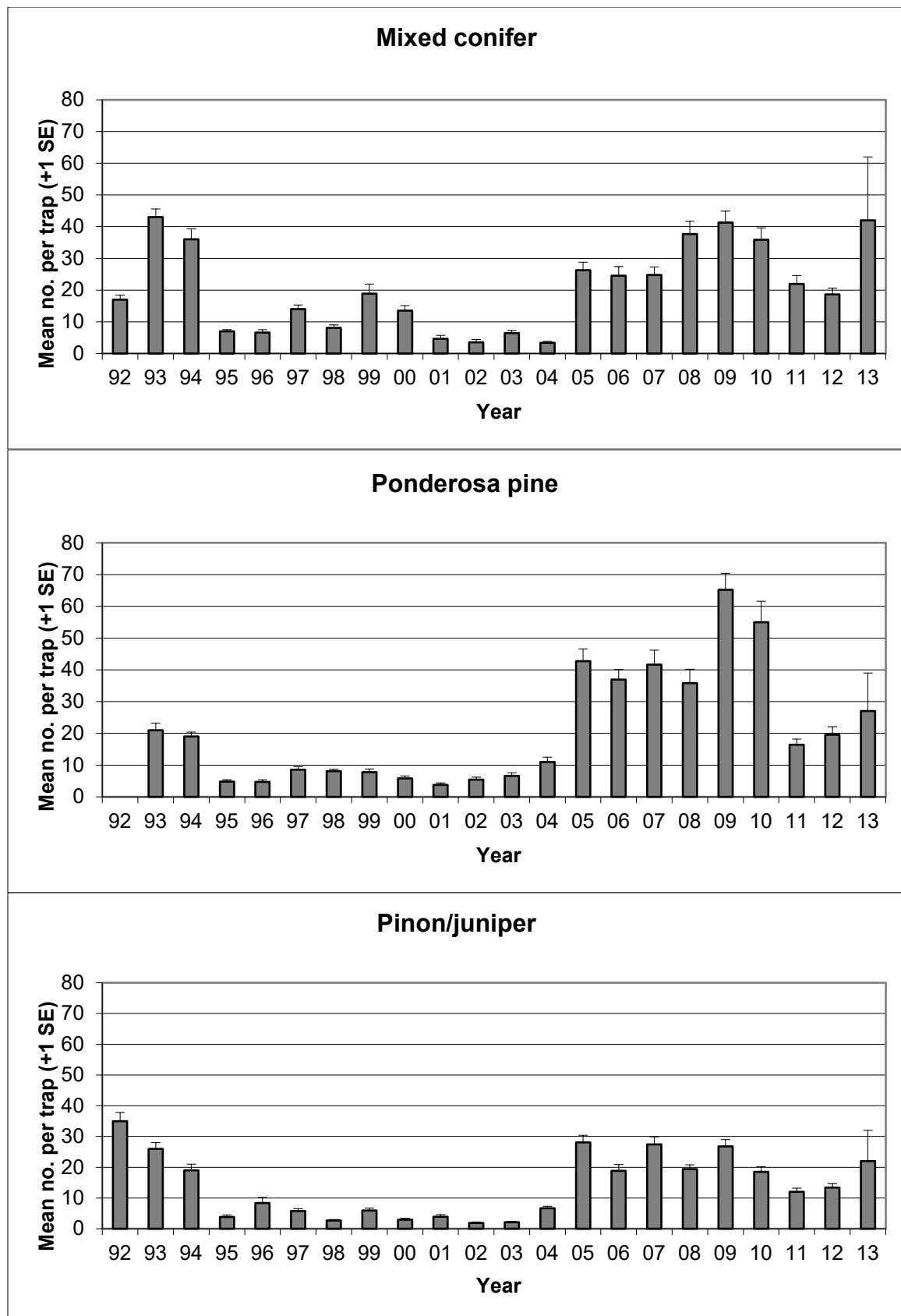
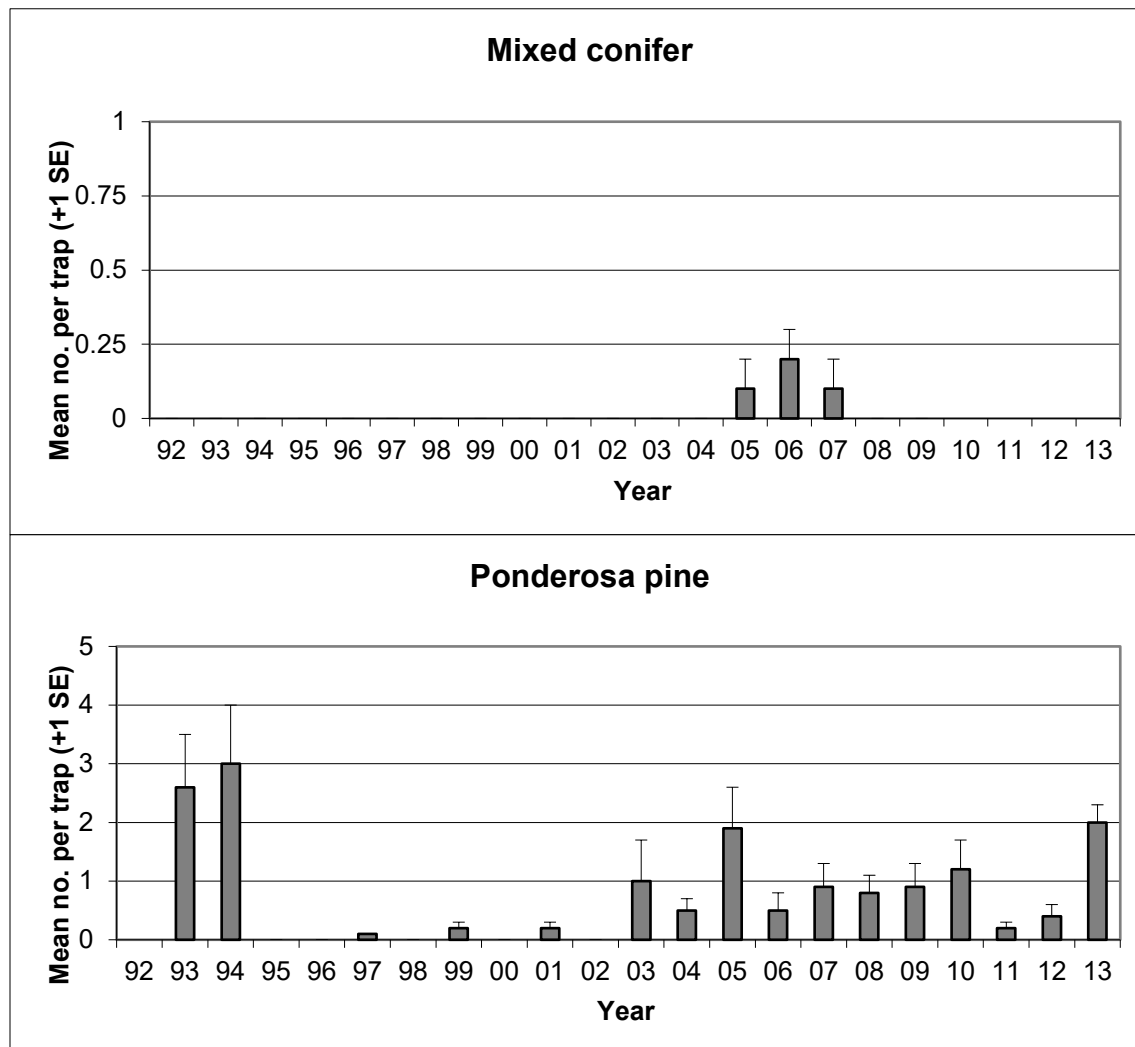


Fig. 4. Mean spider abundance by site and year.

Bristletails were collected almost exclusively at PJ. Their populations seem to alternate years for high and low numbers (their life cycles extend over 2-3 years), except that drought apparently can reduce numbers greatly, almost to the point of local extinction in some years (Fig. 5). Bristletail numbers in 2005 reached their highest levels since 1994, declined again in 2006 and increased in 2007-10. These small detritivores are an important food source for larger arthropod species but are rarely counted in arthropod studies. Many species live in mesic habitats; our *Machilinus aurantiacus* lives in wetter microhabitats in the PJ. In 2011-2013 numbers were essentially zero in PJ sites, but they did experience an uptick in PP sites.



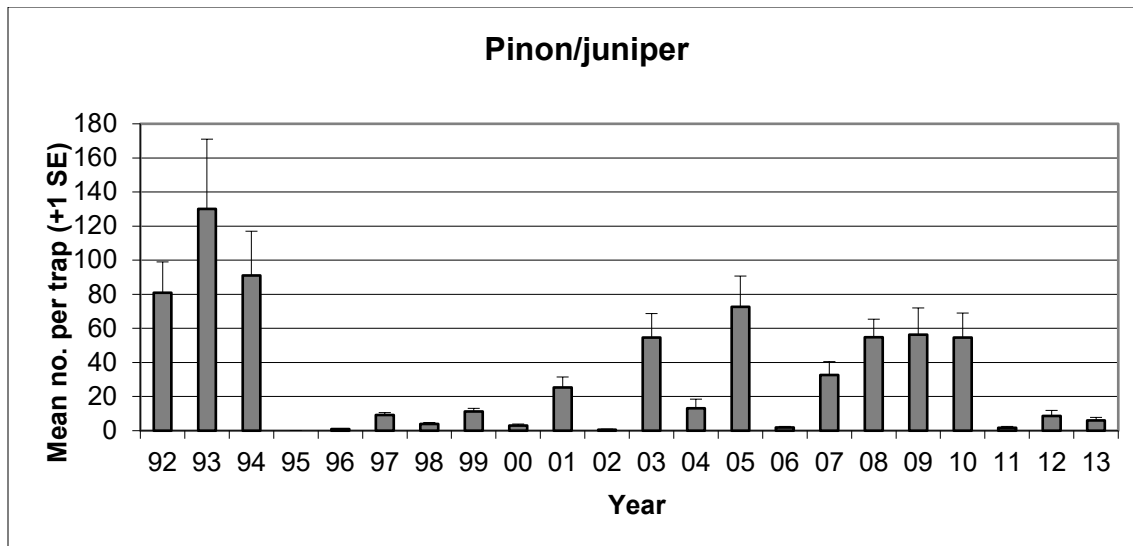


Fig. 5 Mean bristletail abundance by site and year. Note differences in y-axis values.

Cricket abundance data (Fig. 6) included field crickets, Jerusalem crickets and camel crickets. The species are rather restricted by habitat: Jerusalem crickets (*Stenopelmatus fuscus*), field crickets (*Gryllus* sp.) and one camel cricket (*Ceuthophilus pallidus*) are found primarily at the PJ site; field crickets and the other camel cricket (*C. utahensis*) are found at the PP site; *C. utahensis* is found primarily at the MC site. Numbers in 2001 - 2002 were reduced at all sites approximately to 1995 levels. In 2003 numbers increased in PJ and MC, and declined slightly in PP. *Ceuthophilus pallidus* numbers at the PJ site began to decline in 2006 and dropped sharply in 2009 (Table 2), with only 4 collected in the August sample. Their numbers have rebounded to some extent in the last few years. *Ceuthophilus utahensis* numbers showed the opposite pattern by greatly increasing from 2006-2010, especially at MC. In 2011 abundance fell by about half at all three sites. Numbers for *C. utahensis* continued to decline in 2012 and 2013 reaching total numbers about 1/5 those seen in 2010 (Table 2). The field crickets and scaly bush crickets (*Cycloptilum comprehensens*) are collected mostly in June and October samples; camel crickets and Jerusalem crickets in June and August samples.

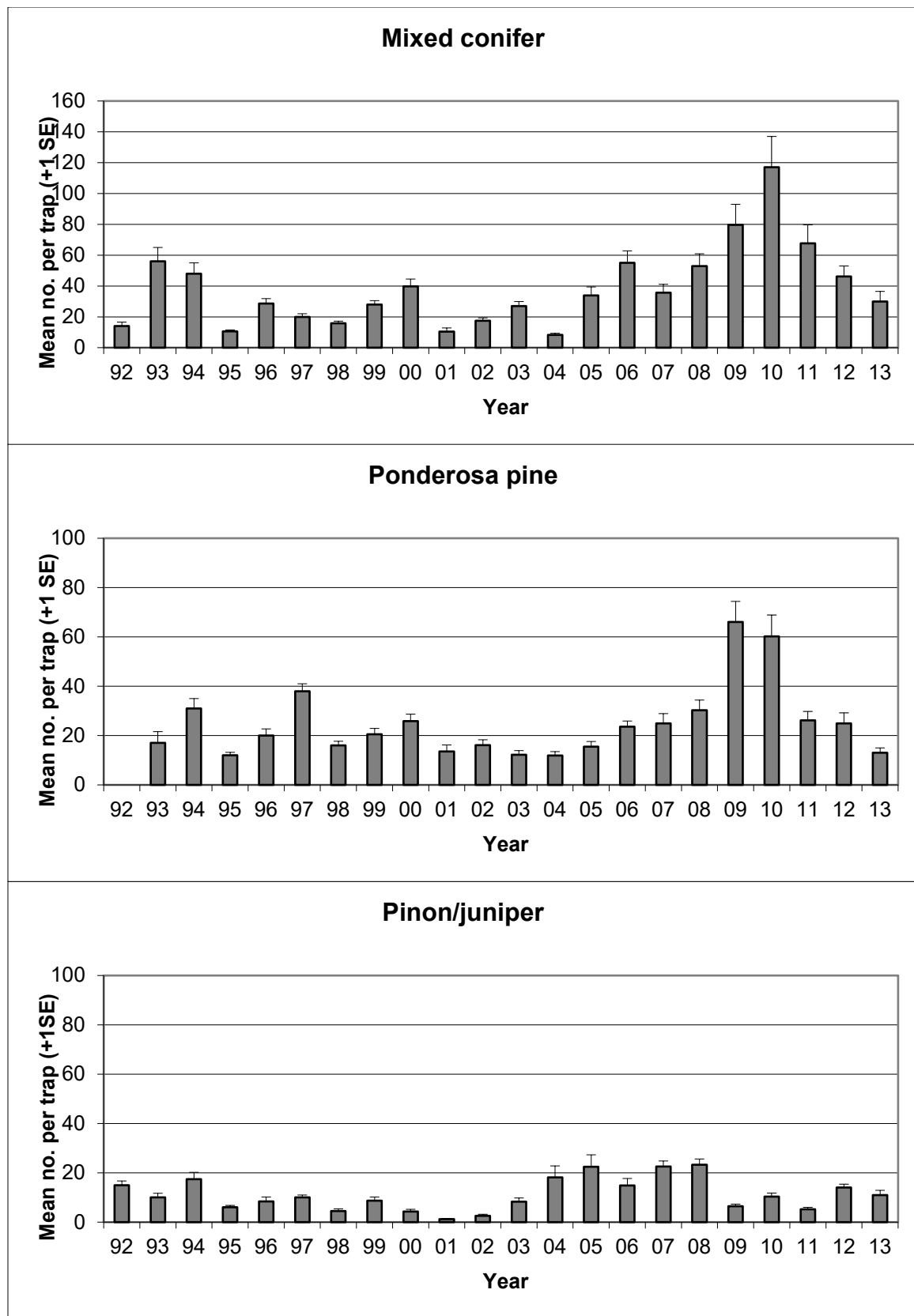
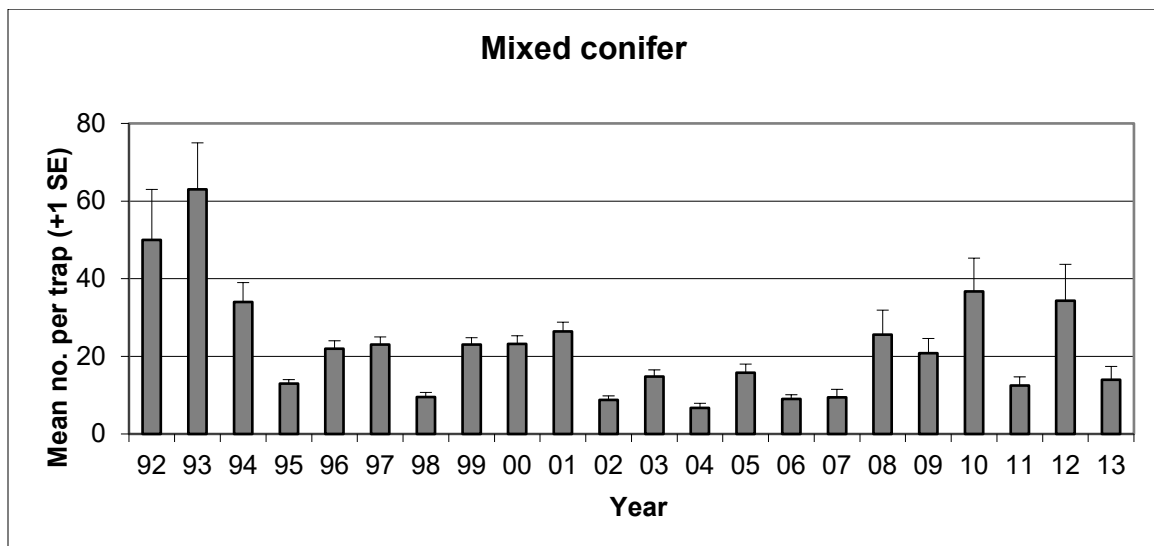


Fig. 6 Mean cricket abundance by site and year.

Ground beetles (Carabidae) are well known indicators of moisture conditions in a variety of habitats. The arid southwest has relatively few species of this large family away from riparian or other moist habitats, and as expected, most individuals were found at the MC site (Fig. 7). Numbers declined in 1995 and 1998 at all sites, and recovered more quickly at MC than at the other two sites. In the wet years 2005-2007 the carabids increased at PJ and MC, and in 2007 at PP we collected over 8,000 specimens of *Pterostichus adstrictus*. The species is common at the Monument, but we have not seen such high numbers of any carabid during the 19 years of this study. It is important to note that the larval stages of these beetles are not well sampled by pitfall trapping (they live in the upper soil), so that we have no way to assess their changes in abundance and what effect those changes may have on adult population numbers. It is also possible that the numbers of *P. adstrictus* in the traps negatively affected the abundance of other taxa in those traps. By 2009-2010 numbers fell to 2006-07 levels. There are about 2 dozen species of ground beetles that regularly occur at the sites. After the *Pterostichus* spp., the next most abundant species is *Carabus taedatus*, also at MC. In 2011 numbers fell by about two thirds (Table 2). In 2012 numbers remained low at PJ and PP but increased at MC, due to *Calathus advena* (none collected in 2011), *Carabus taedatus*, two *Pterostichus* species, and *Rhadine* sp. (137 collected in 2012, but only 1 in 2011). In 2013, ground beetle numbers returned to the low levels of 2011 at MC with both *C. taedatus* and *P. adstrictus* numbers declining to about 25% of the numbers in 2012 (Table 2).



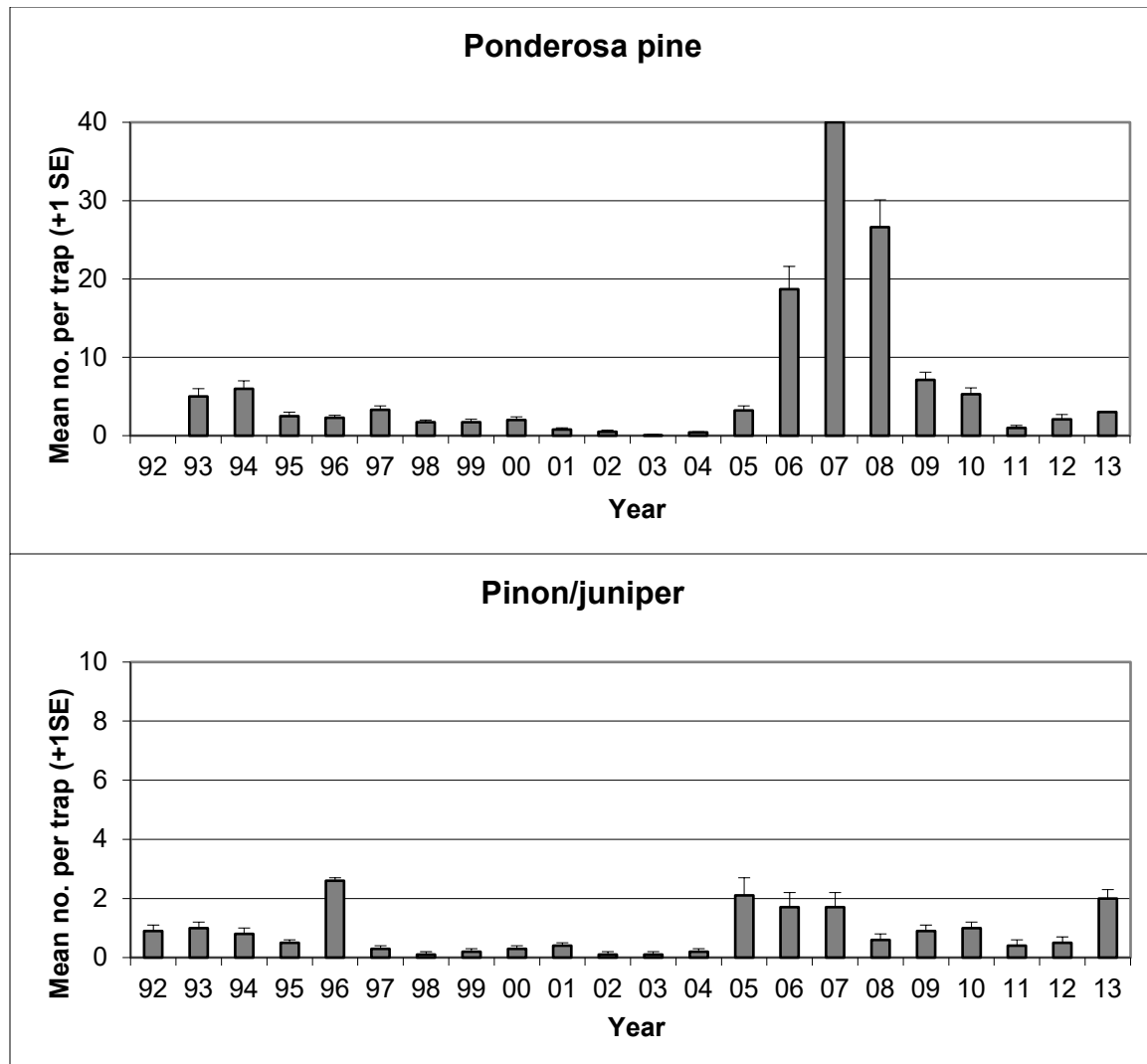


Fig. 7. Mean ground beetle (carabid) abundance by site and year. Note differences in y-axis values. See text for PP numbers in 2007.

The **rove beetles** (Staphylinidae) are a large family with broad feeding habits ranging from predation to detritivory to fungivory. Many are small in size and their identification below subfamily is difficult, especially within the subfamily Aleocharinae. The beetles are usually associated with grass or litter and like the carabid beetles (Fig. 7) prefer mesic habitats. Rove beetle numbers were up at all three sites in 2013 after being virtually absent from all sites in 2012 (Fig. 8). In the past, rove beetles have rarely been collected from PJ, seemingly due to the lack of ground cover. In 2013, their numbers at PJ were up markedly rivalling the numbers at PP in 2013. Virtually no staphylinids were collected at PP or MC from 2002-04. From 2005-09 numbers increased; with a jump in numbers at MC in 2008 and at PP in 2009. Numbers dropped sharply at PP and MC from 2010 through 2012, but bounced up again in 2013. Members of this family may be especially sensitive to drought.

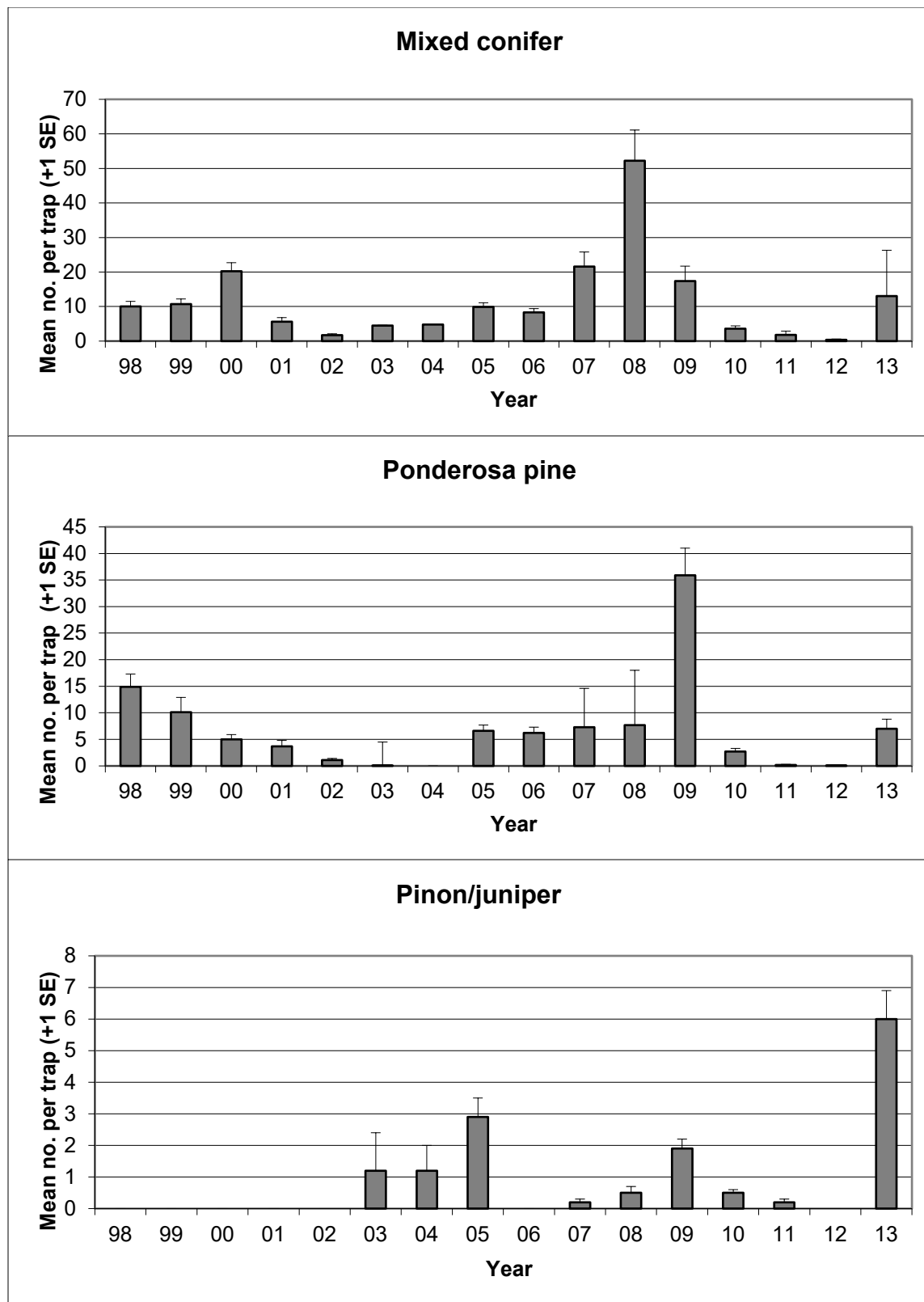
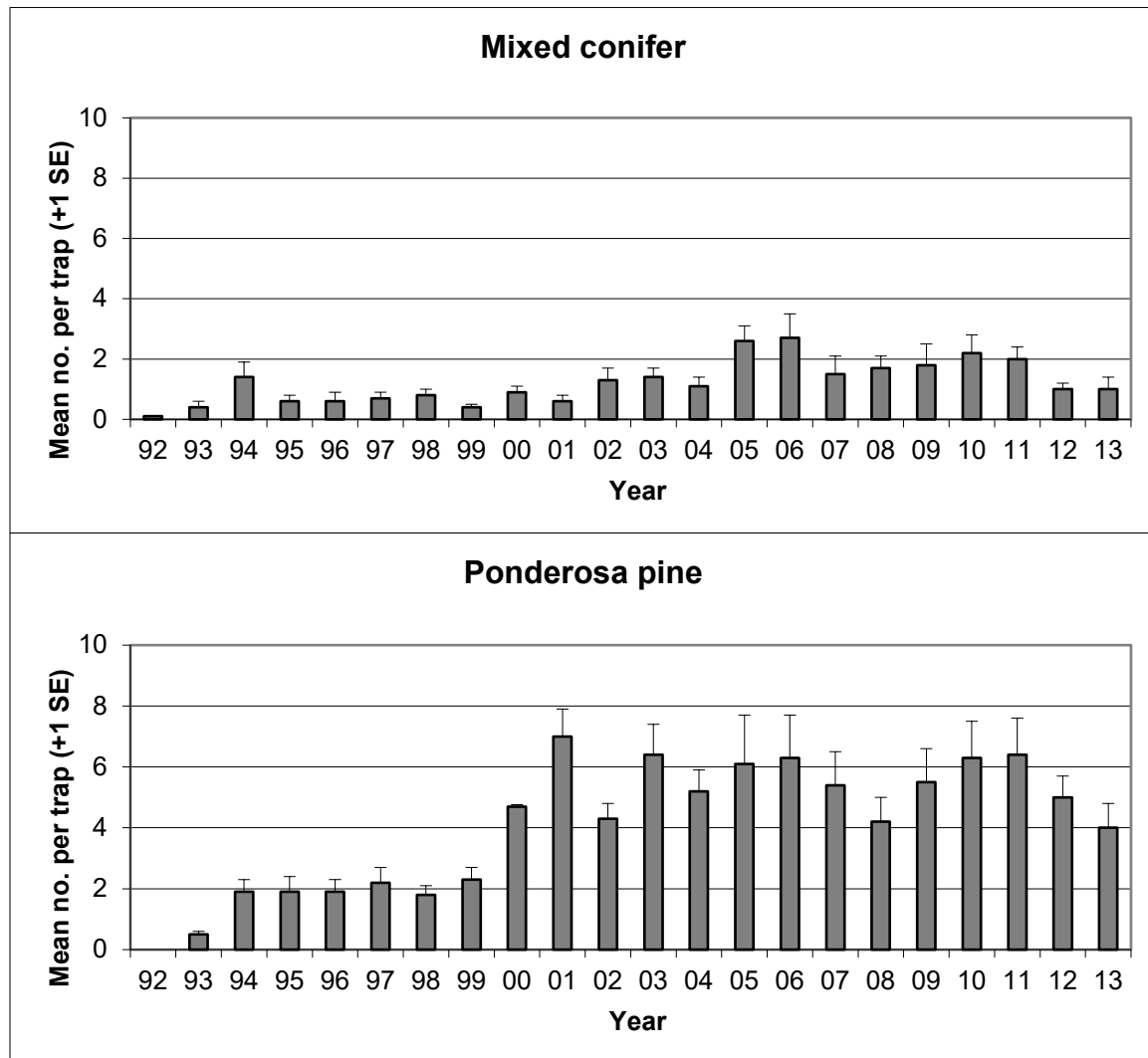


Fig. 8. Mean rove beetle (staphylinid) abundance by site and year. Note differences in y-axis values.

Darkling beetles (Tenebrionidae) are the dominant taxon at PJ (Fig. 9), followed by scaly bush crickets and camel crickets. These beetles seem to be relatively unaffected by short-term environmental changes. For example, compare their numbers with those of spiders (Fig. 4). However, they have apparently benefited from the wet winters between 2005 and 2009. Numbers fell in 2010 to levels comparable to 2008 and fell again to 2001 levels in 2011 and 2012 but bumped back up to 2005 levels in 2013. *Eleodes obscurus* has been considered the dominant species in PJ. It is one of about 10 species found on the Monument and is very conspicuous because of its large size (~35mm). Its numbers have, however, steadily decreased seen 2009 to about 1/10 the number seen in that year (Table 2). Other smaller darkling beetle species' numbers increased in 2013 (especially *Steriphanus convexus* and *Araeoschizus decipiens* in the April and June 2013 PJ samples), and accounted for the increasing number of Tenebrionids. All of the tenebrionids are detritivores. The life span for *Eleodes* species can be 5 years or more.



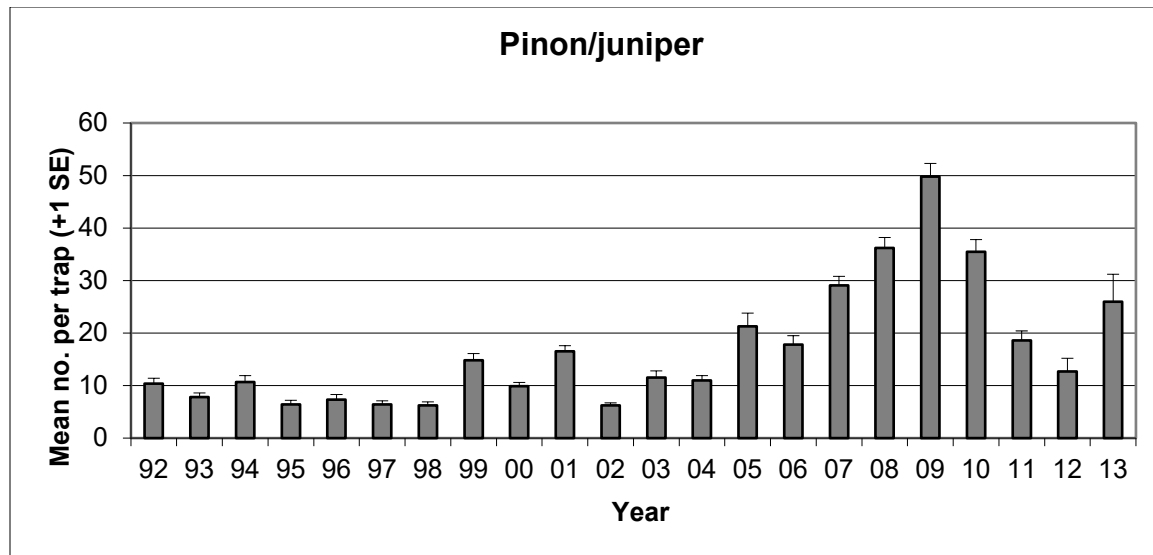


Fig. 9. Mean darkling beetle (tenebrionid) abundance by site and year. Note differences in y-axis values.

An additional line of pitfall traps (Line F) was established at the MC site to monitor **ants** (as a food resource for salamanders) in an area that had burned in the La Mesa fire of 1977. Abundance data for ants from pitfall traps (which primarily target solitary wandering arthropods) should be used cautiously because establishment or decline of colonies near traps can greatly affect pitfall captures. The E line is closer and was more similar to the F line before the burn, and so was chosen for comparison to see if the F line ant community became similar to that of the E line. However, lines E and F have varied unpredictably in relation to each other over the course of this study (Fig. 10). The pitfall traps collect about 10 species, with formicines in the genera *Camponotus* and *Formica* making up the majority. In June 2010 trap E2 contained 194 *Formica laeviceps*, an unusual occurrence probably due to the trap being near a nest opening or a foraging route. A similar occurrence in 2011 of 335 *F. laeviceps* also from trap E2 skewed the data from the generally low numbers of individuals. In general, the E line traps more ants than the F line, but the numbers vary so much that it is hard to say whether the difference is due to fire, drought, or some other environmental factor.

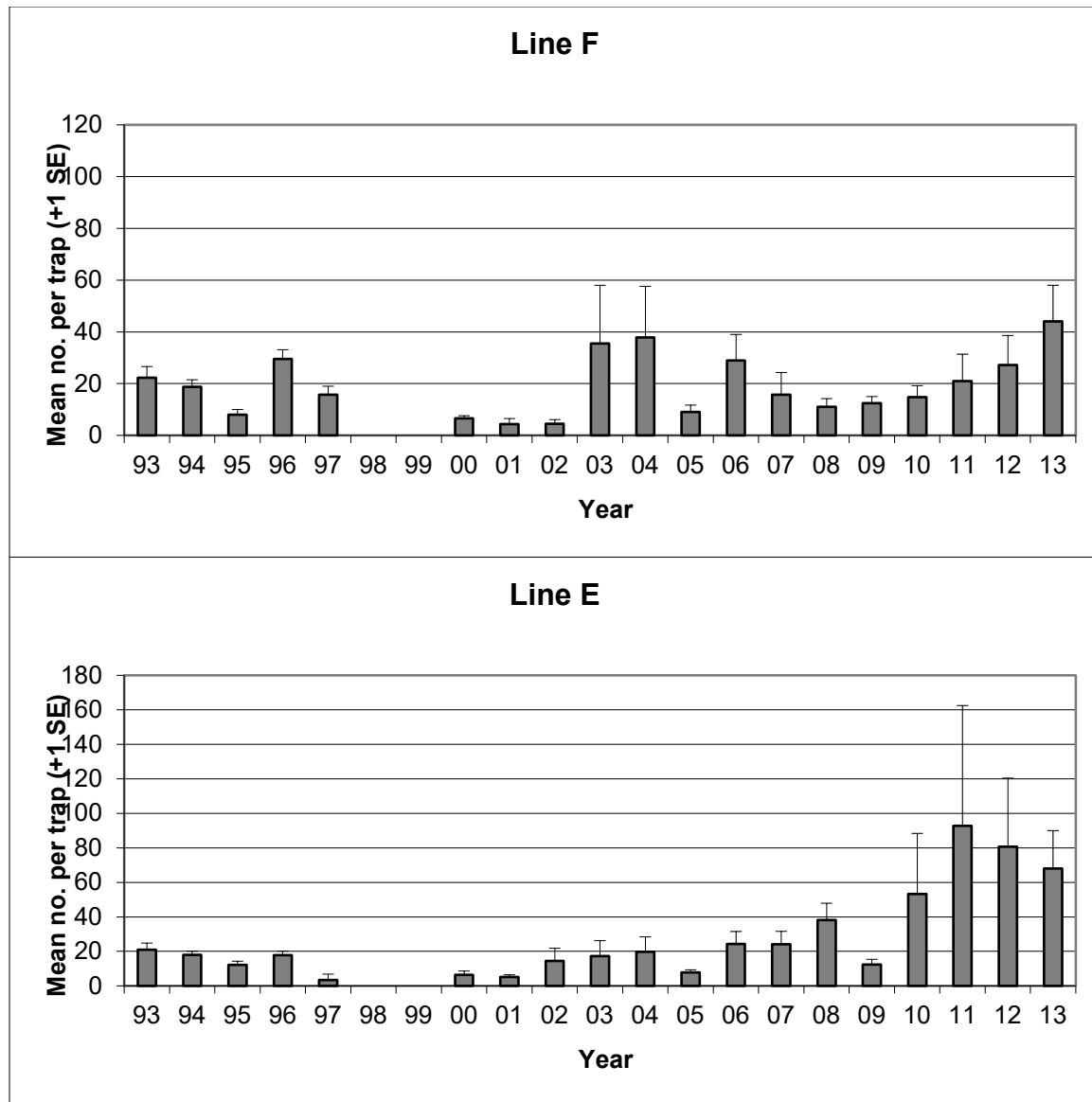


Fig. 10 Mean ant abundance on the MC E and F lines.

Summary

Twenty-one years of arthropod data from pitfall traps have revealed habitat preferences of species from the three vegetation zones and have shown that abundances vary greatly from one year to another (Table 2). Species richness patterns show that a few species dominate a given vegetation zone and that there are many rare species, resulting in a species list with several hundred taxa (Appendix 1). In species richness the PP and MC sites are more similar to each other than they are to the PJ site. The mean number of species in a trap was 18 at PJ, 18 at PP and 17 at MC in 2010 and dropped to 14.9, 12, and 14.5 respectively, for 2011 (Fig. 3). Species show rather high site fidelity and even when a species occurs at two sites, the abundance is almost always much higher at one. It appears that a single wet or dry year has little impact on these mostly

generalist species, but a series of wet or dry years can strongly influence abundance (and richness at PJ).

The PJ site shows the most variation in abundance and changes in richness. In the last several reports new records for species tended to come from this site, but not every species is caught every year. PJ also seems to be hit hardest by droughts that occur over several years (Fig. 2). One of the more interesting patterns observed in 2013 was the dramatic rise in numbers of rove beetles in PJ. By comparison the MC site is more stable, and the PP site is increasing in abundance as overstory vegetation was returning (until the fire of 2011). It is important to monitor the arthropods at the species level whenever possible, because they are not redundant. There is turnover along the gradient, of course, but the trajectories of the species may be different. For example, of the two main camel cricket species, *C. utahensis* at PP and MC is currently declining, while numbers of *Ceuthophilus pallidus* at PJ are fluctuating up and down (Table 2). After the Las Conchas fire, the traps at PP and MC give us a rare opportunity to document the pattern of the arthropods' return. However, it is unclear whether differences in fire severity at trap lines within a site may confound attempts to discern these patterns (Table 1).

Taxa of special interest from 2013

The first year earwigs were collected was 2009. The species is the introduced and widespread European earwig, *Forficula auricularia* and all have been at the MC site, on the A and D lines. None of these were encountered in 2013.

The ground beetle *Rhadine* has usually been collected in low numbers, but there were 77 in 2013 and 137 in 2012 compared with only one and two encountered in the years 2011 and 2010 respectively.

After comparing ground beetle species in the 2013 samples with ground beetles in the reference collection at the Valles Caldera, we believe that carabid sp. 38 is *Sericoda bembidioides*. Members of the genus *Sericoda* are pyrophilous and are attracted by burned areas after fire. If this identification is accurate, it would be worthwhile to examine numbers for carabid sp. 38 through time in forested sites to see if numbers correspond at all to past burn patterns. Based on the identification of pterostichine species at the Valles Caldera by Danny Shpeley, we suspect that many of the *Pterostichus* species identified as *Pterostichus* sp. 1 in the Bandelier study may be *Pterostichus restrictus*. The ground beetle species *Selenophorus planipennis* was observed in 2013. This species was in the Bandelier reference collection, but did not appear on the species list for this project (Appendix 1).

Although not a target species, several individuals of *Omorgus* sp. belonging to the hide beetle family Trogidae were found in 2013. While individuals of the

Trogidae, namely *Trox sonorae*, have previously been documented in this study, individuals of the superficially similar genus *Omorgus* have not.

The grasshopper species, *Trimerotropis melanoptera*, was recorded for the first in this study at PJ line D in Oct 2013.

Three apparently new species of ground beetles were collected in 2013, these were entered as species 46-48 in the species list.

Several new rove beetle species (Staphylinidae) were collected in 2013. Mark spent a lot of time working on the staphylinids and struggled with definitive identifications even at the morphospecies level in this group. In the process, he created a number of new morphospecies 19-39 (entered as species 19-39) that could potentially be folded back into the previously established morphospecies groups depending on how broadly one wants to define the different morphospecies in the Bandelier reference collection. We do not believe that the quality of past identifications within this group warrant the time necessary to go beyond the family level for this group in the future.

Several new species of sap beetles (Nitidulidae) were collected in 2013. These were labeled as Nitidulid species 16-19. The previously completed identifications within the Nitidulid family done by Michele Price established an excellent reference collection for this family. Even so, species level identifications for some genera within this family (e.g. within the genus *Thalycra*) may require expertise of her caliber to distinguish individual species. The additional collected species in 2013 did not appear to match any of those in the reference collection that she developed.

Several new species of weevils (Curculionidae) were collected in 2013. These were assigned as morphospecies 39-53 and labeled as Curculionid species 39-53. In 2015, Dr. Robert Parmenter of the Valles Caldera National Preserve sent representative specimens for most of the previously identified morphospecies in this family in the Bandelier reference collection to Dr. Don Chandler at the University of New Hampshire for identification work. In some cases this included the sole pinned examples of some of morphospecies 1-38, therefore it is possible that some members of morphospecies 39-53 match members of morphospecies 1-38 that were not available for comparison.

One new species of click beetle (Elateridae) was collected in 2013. This species was labeled as Elaterid species 18.

In the seed bug family (Lygaeidae), it is believed that morphospecies 5 is the small milkweed bug (*Lygaeus kalmii*). Several new species of seed bugs were collected in 2013. These consisted of morphospecies 14, 16, 17, 18, 20, 22, and 25 and were labeled as Lygaeid species 14, 16, 17, 18, 20, 22, and 25 respectively.

Representative examples of individuals belonging to all new morphospecies documented in 2013 have been pinned and will be properly labeled for addition to the Bandelier reference collection housed at MSB to aid future identification efforts. Also new species codes for all newly identified species were added to the master species list (Appendix 1) and highlighted to denote new additions.

Discussion

The total time required for sorting, identifying and entering data for the 2013 samples took approximately 650 hours. More than half of this time was spent sorting (340 hours). Approximately 280 hours was spent on specimen identification (with about 115 hours of this time spent on the smaller beetles and true bugs). Even so, we did not attempt to identify or count members of the Cryptophagidae, Leiodidae, Lathridiidae, or Anthicidae in the 2013 data set. The number of apparent matches in these families with the Bandelier reference collection was very low. This gave us concern about the reliability of past counts within these families in the data set. We did not feel that it was a prudent use of our time to put in the significant effort that would have been required within these groups to develop an improved reference collection. Although this decision may slightly alter total counts for abundance and richness data for 2013, we believe that it will be an insignificant difference. We do not recommend attempting to identify members of these families in the future unless greater quality control can be assured.

All of us involved with the pitfall study (Craig Allen, Kay Beeley, Robert Parmenter, Dave Lightfoot, Mark Ward, and Sandra Brantley) will meet in February 2016 to evaluate the taxa and sample processing time. From Mark's time assessment it is clear the project must cut some taxa or broaden the level of identification from species to genus or family if the study is to continue. At present there are two years of samples yet to be sorted. Identification to the family level is still informative for some groups and allows us to keep them in the study, while recovering time spent in attempting species-level identifications for taxa we do not know well. We are also looking into hiring technicians to sort specimens to the order level, so that we can focus on identifications and analysis.