Abstract:

The purpose of this study was to examine the effects of fire and logging on insect diversity within a ponderosa pine forest. We hypothesized that the most diversity would be found in the control area, which was supported by the data collected. The logged area had the least diversity and the burned area had an intermediate amount. Our data indicates that disturbance in a forest ecosystem has a negative effect on insect ecology. Since this experiment was conducted on Shanahan Ridge, near Boulder, the implications for regional forest management are particularly relevant.

Introduction:

We studied the effects of two disturbances, fire and logging, on the diversity of insect species in a ponderosa pine community on Shanahan Ridge during early winter. The purpose of this research is to determine how, if at all, these disturbances alter insect diversity and, once completed, to determine whether any changes in insect diversity are severe enough to permanently or negatively alter the ecology of the area. The only other studies in the area (Boulder City foothills) concerning insect diversity have focused on changes in diversity along elevational and spatial gradients (Boulder City Open Space 1993), and on changes in diversity due to the effects of fire in a ponderosa pine community (Klopfer and Deranleau 1995). Klopfer and Deranleau (1995) conducted their study in April and found snow fleas, Collembola, to comprise the majority of their specimens, indicating relatively low insect diversity. No studies that examine the effects of logging on insect diversity in the area could be found, though, and the Boulder City Open

Space study (1993) is not appropriate for making comparisons because it did not address the effects of either disturbance. Because we conducted our research in early, rather than late, winter, and are studying the effects of logging, in addition to fire, on insect diversity, our research will add to the current knowledge gained from past studies.

Data collected from this experiment, especially when combined with past studies, will reveal facts concerning the changes in distributions of insects as a result of natural events, including seasonal variation and fire, and man-made events, including logging and fire. There is currently a need for such research for several reasons. First, as mentioned earlier, little is currently known about the effects of disturbances on insect diversity, especially in the Boulder area. Second, insects comprise a surprisingly large percent of both the overall biodiversity and biomass of a forest community and provide many services including nutrient cycling, pollination of food for predators such as threatened or endangered bat and migratory bird species (Elzinga, 1987). Therefore, a change in the abundance or distribution of insects may cause changes in the trophic structure of a community and could affect organisms both above and below insects on the food chain.

Methods:

An inventory of equipment used in our study is included below:

- six 1 meter sections of baseboard
- a small shovel
- twelve jars
- a preserving agent (Sierra antifreeze)

- six wooden covers to prevent snow from collecting on the pit-traps
- a filter net to extract the insects from the jars
- Two fifty meter transect lines
- a dissecting microscope

Procedure:

Our experiment was conducted on Shanahan Ridge, a ponderosa pine forest right outside of Boulder, Colorado. This is an ideal location as it has a relatively uniform elevation and logged, burned, and undisturbed ponderosa pine communities in close proximity to each other.

Two insect pit-traps were placed at randomly determined locations within each study site. Random sampling was necessary in order to ensure that our sample sites were representative of the area studied. Standing in the approximate middle of the sample site, marked as '0', we used the measure of centiseconds on a stopwatch to obtain a random compass bearing. We then worked this direction, and, using the stopwatch again, obtained a random distance (from 1-60 meters) at which to place our first trap. Returning to our '0' point, we repeated the above process to determine the location for our second trap. We duplicated this process for the other two sample sites. The pit-traps consist of a one meter section of baseboard placed on the forest floor with two jars at either end of it buried so that their openings are level with the ground. As insects encounter the baseboard, they are forced to travel parallel along it's length in an effort to circumvent it, only to fall into the jars at either end as they make their way around the obstruction. Sierra antifreeze, a preserving agent, was poured in the jars to both kill and preserve the insects for study. The traps were in place from Tuesday, November 28th to Wednesday, December 6th. Insects were collected from the capture sites every couple of days and the equipment checked to make sure it was working properly.

We identified the collections under a dissecting microscope, relying on several literary sources (Elzinga, 1987; Kaston, 1953; Cranshaw, et al., 1995; Jaques, 1939), for keying the insects down to the family. After the data was categorized, we recorded it onto a spreadsheet (Excel). Several types of data analysis were used in our site comparisons. Diversity was calculated using the Shannon-Weiner index, and richness was compared by counting the number of families in each site. Finally, the percent similarity between the sites was calculated.

Results:

We used the Shannon-Weiner Index to show the diversity of insects at each site; the control area had an H value of 0.948, the burned area had an H value of 0.757, and the logged area had an H value of 0.679 (see Figure 1 and Table 1). We also performed tests to determine the family and order richness. The family richness values are as follows; the control area had a f value of 10, the burned area had a f value 9, and the logged area had a f value of 5 (see Figure 2 and Table 2). For the order richness; the control area had a value of 6, the burned area had a value of 5, and the logged area had a value of 8 (see Figure 5 and Table 2). We also ran a test to find the percent similarity between the communities; the similarity between the burned and the control is 0.322, the similarity between the burned and logged is 0.376, and the similarity between the control and logged is 0.250 (see Table 3).

Discussion:

The results of our study support our hypothesis indicating the highest percent of richness and diversity occurred at the control site. Due to the lack of disturbance, the control site had not only the largest diversity index (0.948), but also the highest family richness (10) as demonstrated in Table 1 and 2, and Figure 1 and 2 respectively. One explanation for these results may be that the control site contained a wider variety of niches for diverse species to inhabit due to non-disturbance.

In an unpublished study, performed at Shanahan Ridge by Stone et al. (1995) percent ground cover was examined in burned, logged, and control areas. Stone et al found that the burned area had the greatest total live coverage with a mean of 71%. The control site had slightly less, with a mean of 62%. The logged areas had a relatively low proportion of total live coverage, with a mean of only 23%. When comparing the disturbed areas, insect diversity was highest in areas with higher ground cover. That is, insect diversity was highest in the burned area. Even though the control had lower ground cover but higher insect diversity, this can be explained due to its undisturbed nature.

The control and logged site shared the least percent community similarity (25.0%) indicating that logging had a more severe impact on insect diversity. The burned and logged sites were the most similar with a similarity of 37.6%. The burned and control sites had a similarity of 32.2% (see Table 3).

Our data does not support Klopfer and Deranleau's study, (1995); they found an extremely low percent similarity between the control and burned sites (1.4%). This contradiction may be due to the lack of snowpack in our study area, the different sites that were examined, or the different elevation of the two study areas.

Although diversity was highest in the control site, we found the greatest abundance in the burn sites. Insects of the order Hymenoptera, and Coleoptera did especially well in the burned area. The reason for a high abundance of insects in the burned site may be a direct result of the adaptability of certain insects to the nutrients released after a forest fire. One study reveals that nutrients in the bark of burned pine trees can be twice as digestible as non-burned trees (Jakubas et al. 1994), which may explain the species abundance found in the burned area. Furthermore, a burned forest returns nutrients to the soil, allowing plants to flourish and supplying a source of food and shelter for the insects.

The logged sites contained the fewest number of insects (see Figure 3 and 4, and Table 4) indicating logging contributes to a significant loss of insect diversity and abundance. A possible explanation of this results may be due to the exportation of nutrients from the area.

Future studies would need to address other environmental factors that may influence the insect populations in burned and logged areas of forests. These include: ground cover, forest canopy, soil types, precipitation, the time of year, and temperature. Also, a longer study would provide a more detailed account of the insects present. In addition, the utilization of more traps, and possibly use of a Berlese funnel to examine subterranean insects would provide more data. Accounting for these factors in a follow up study will provide for a better understanding of the effects of logging and burning on insect populations, leading to a better understanding of the role insects play in an ecosystem.

Literature Cited

City of Boulder, U.S. Forest Service, Colorado State Forest Service. 1982. Forest Management Plan: Mountain Parks and Open Space Lands. Colorado State Forest Service.

Cranshaw, W., and Kondratieff, B. 1995. Bagging Big Bugs. Fulcrum Publishing : Golden, Colorado.

Deranleau, G., and Klopfer, M. 1995. Effects of Fire on Insect Communities in a Ponderosa Pine Forest. University of Colorado, Boulder, Colorado.

Elzinga, R.J. 1987. Fundamentals of Entomology. Third Edition. Prentice Hall, United States.

Essig, E.O. 1958. Insects, Mites of Western N. America. New York : Macmillan Co.

Jacques, H.E. 1939. How to Know the Insects. Jacques, Iowa.

Jakubas, W.J.; Garrot, R.A.; White, P.J.; and Mertens D.R. 1994. Journal of Wildlife Management. 58 (1) : 35-46. Abstract Only.

Kaston, B.J. 1953. How to Know the Spiders. WM.C. Brown Co. : Dubuque, Iowa.

Kruess, A.; Tscharntke, T. 1994. Habitat Fragmentation, Species Loss, and Biological Control Science. 264 (5165) : 1581-1584. Abstract Only.

Leather, S.R.; Walters, K.F.A.; and Bale J.S. 1993. The Ecology of Insect Overwintering. Cambridge Press : Great Britain.

Marchand, P.J. 1987. Life in the Cold: An Introduction to Winter Ecology. Univ. Press of New England, Hanover and London.

Table 1

Shannon-Weiner Diversity Index						
Area	**H value**					
Control	0.948					
Burned	0.757					
Logged	0.679					

Table 2

Family Richness	
Area	**f value**
Control	10
Burned	9
Logged	5
Order Richness	
Area	**f value**
Control	6
Burned	5
Logged	8

Table 3

Percent Community Similarity		
	Control	Burned
Control	********	0.322
Logged	0.250	0.376

Table 4

Insect Diversity on Shanahan Ridge				
Order	**Family**	**Control**	**Burned**	**Logged**
Coleoptera	Syphonapter	3	0	0
Coleoptera	Curculionidae	0	0	1
Lepidoptera	Geometridai	1	1	0
Hymenoptera	Formicidae	3	9	2
Diptera	Asilidae	0	1	0
Orthoptera	Gryllidae	1	1	1
Hippodamia	Paranthesis	0	1	0
Coleoptera	Staphylinidae	0	6	0
Diplopoda	Eurymerodesmidea	1	0	1
Aranae	Amamabiids	2	1	0
Aranae	Pholcidae	1	0	0
Aranae	Gnophasidae	4	1	0
Aranae	Theridiidae	2	0	0
Aranae	Lycosidae	2	0	0
Aranae	Thomisidae	0	0	1
Isopoda		0	2	0
		Control	Burned	Logged
	N=	20	23	6

Figure 1

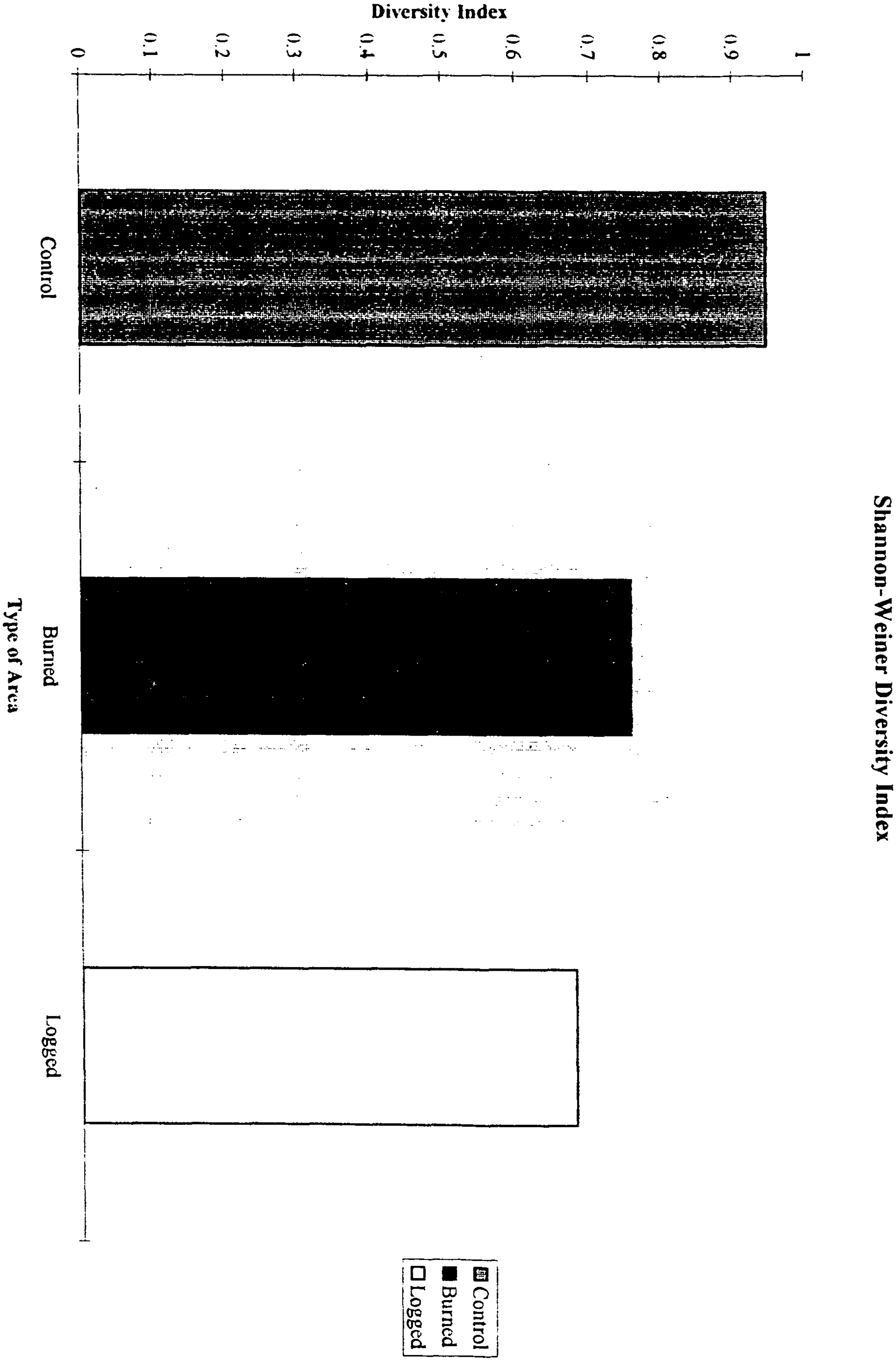

Shannon-Weiner Diversity Index
Diversity Index
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Control
Burned
Logged
Type of Area
Control
Burned
Logged

Figure 2

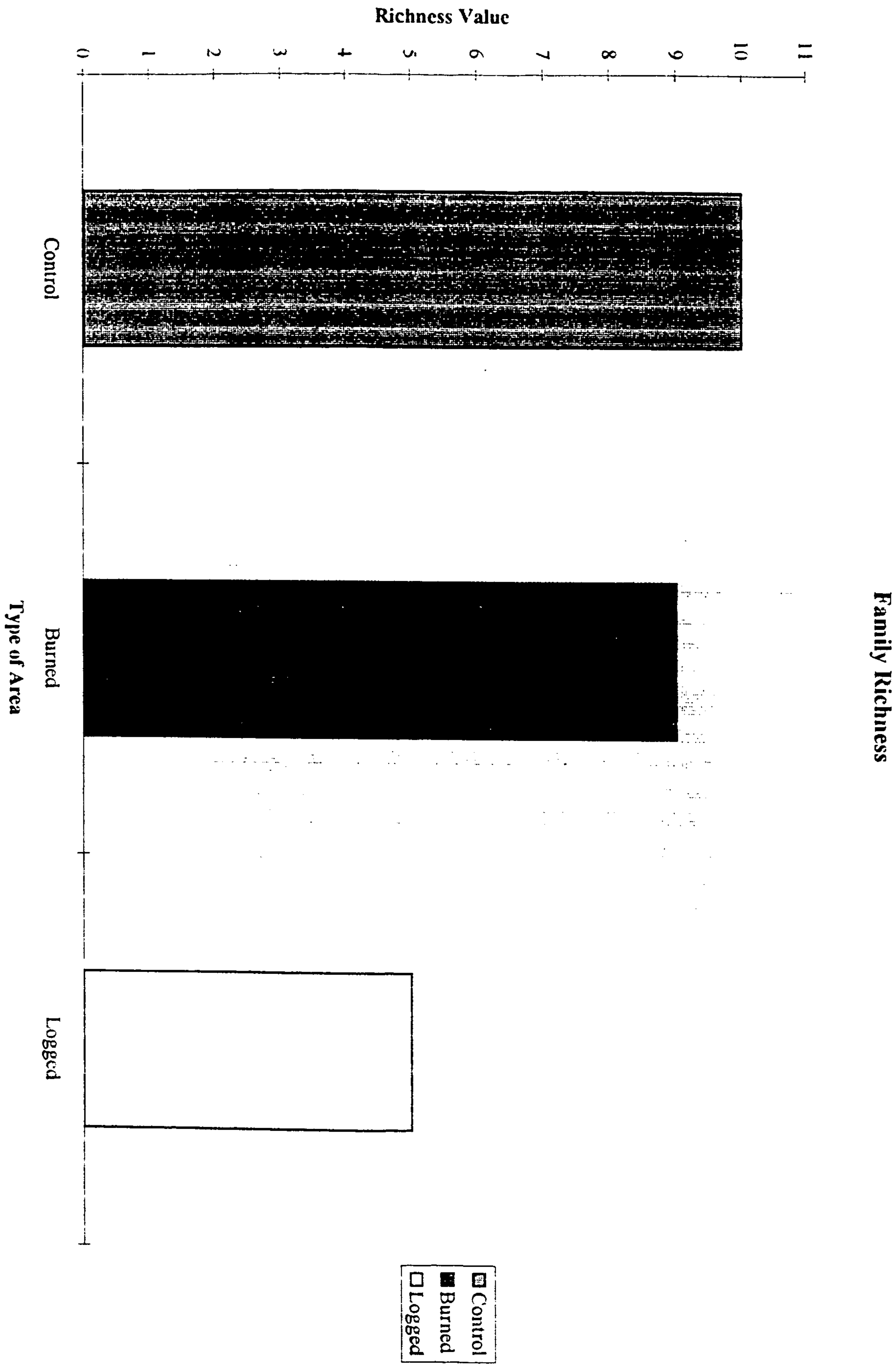
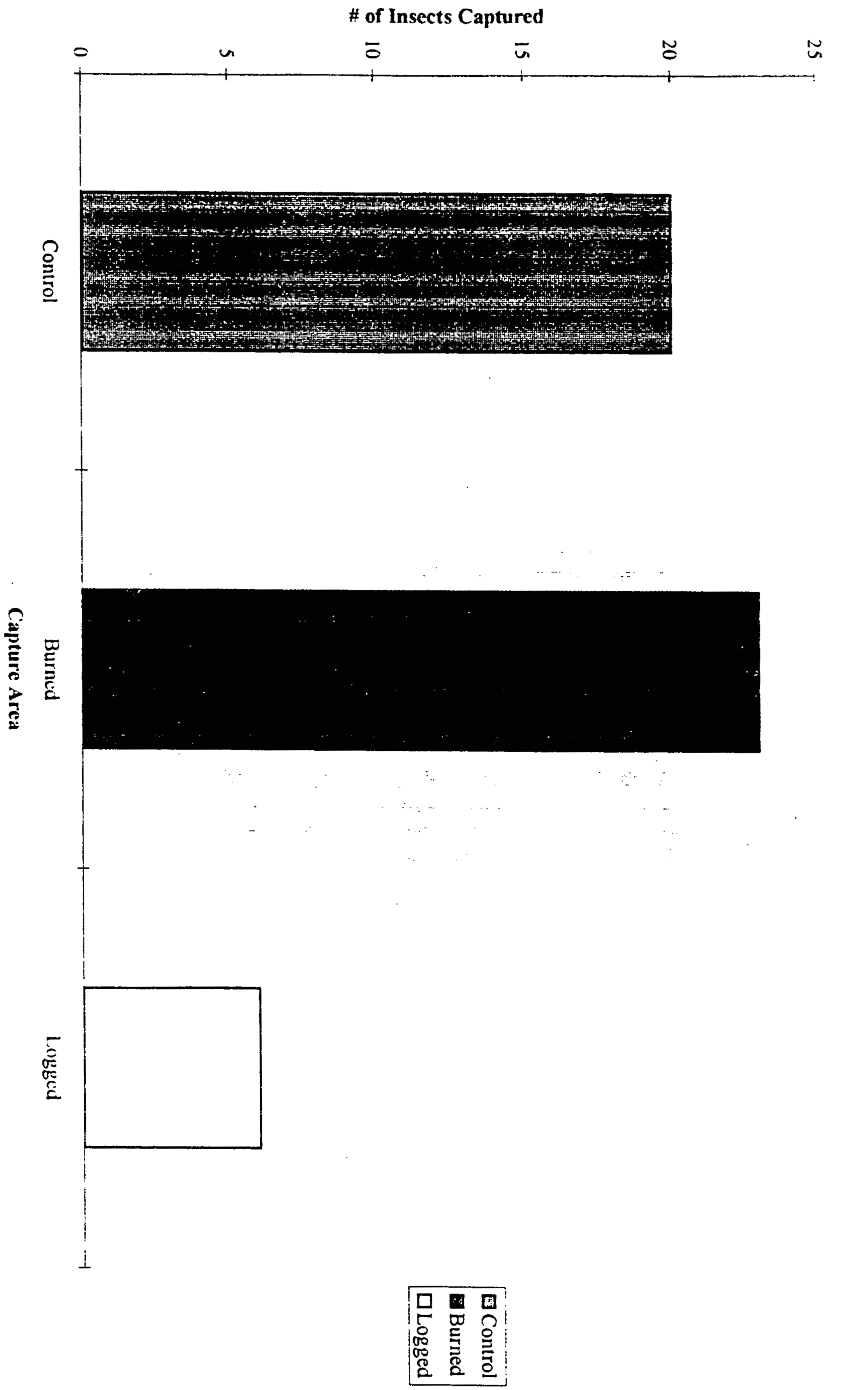

Family Richness
Richness Value
0
1
2
3
4
5
6
7
8
9
10
11
Control
Burned
Logged
Type of Area
Control
Burned
Logged

Figure 3

Total Number of Insects Captured in Each Area



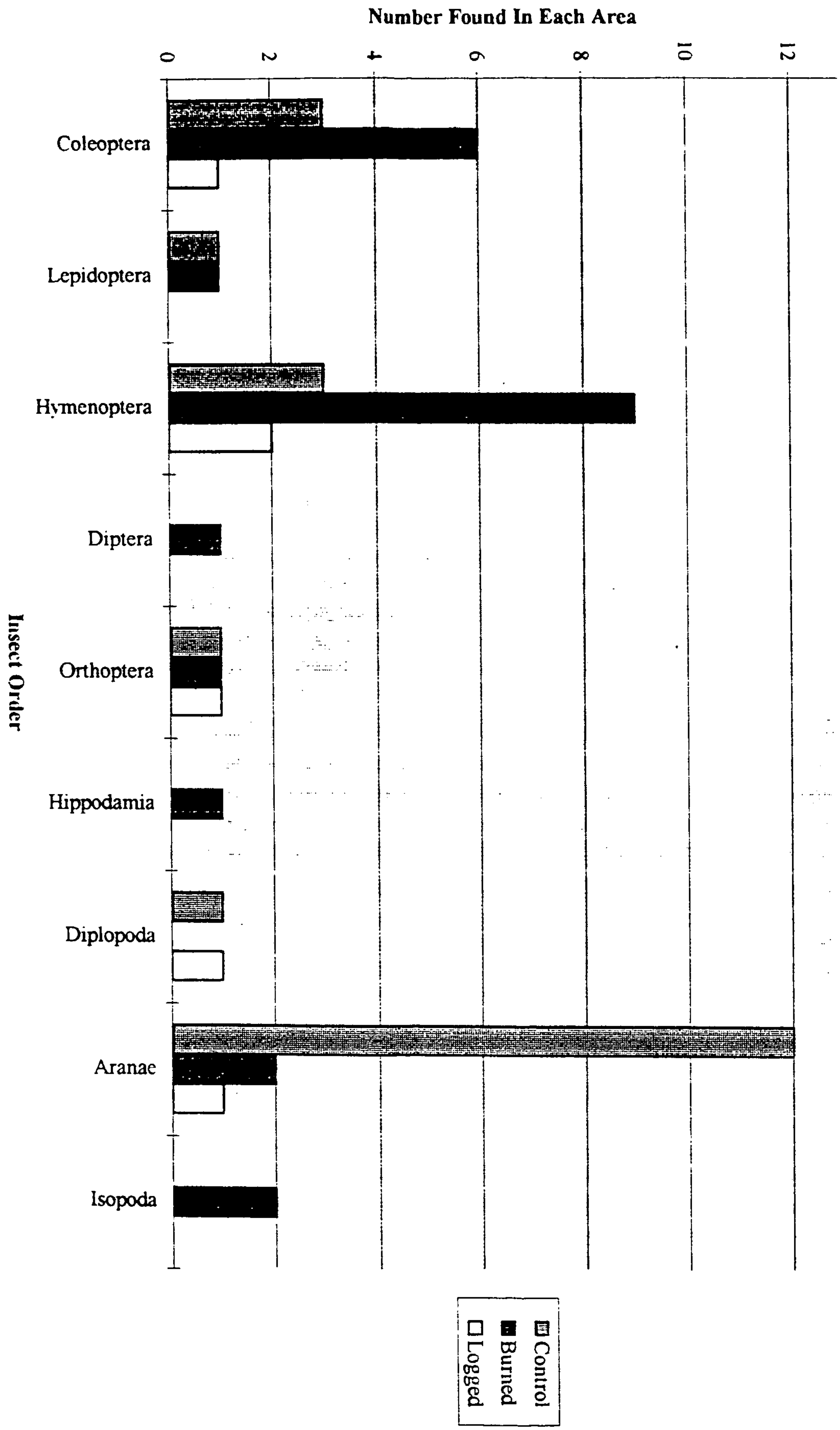
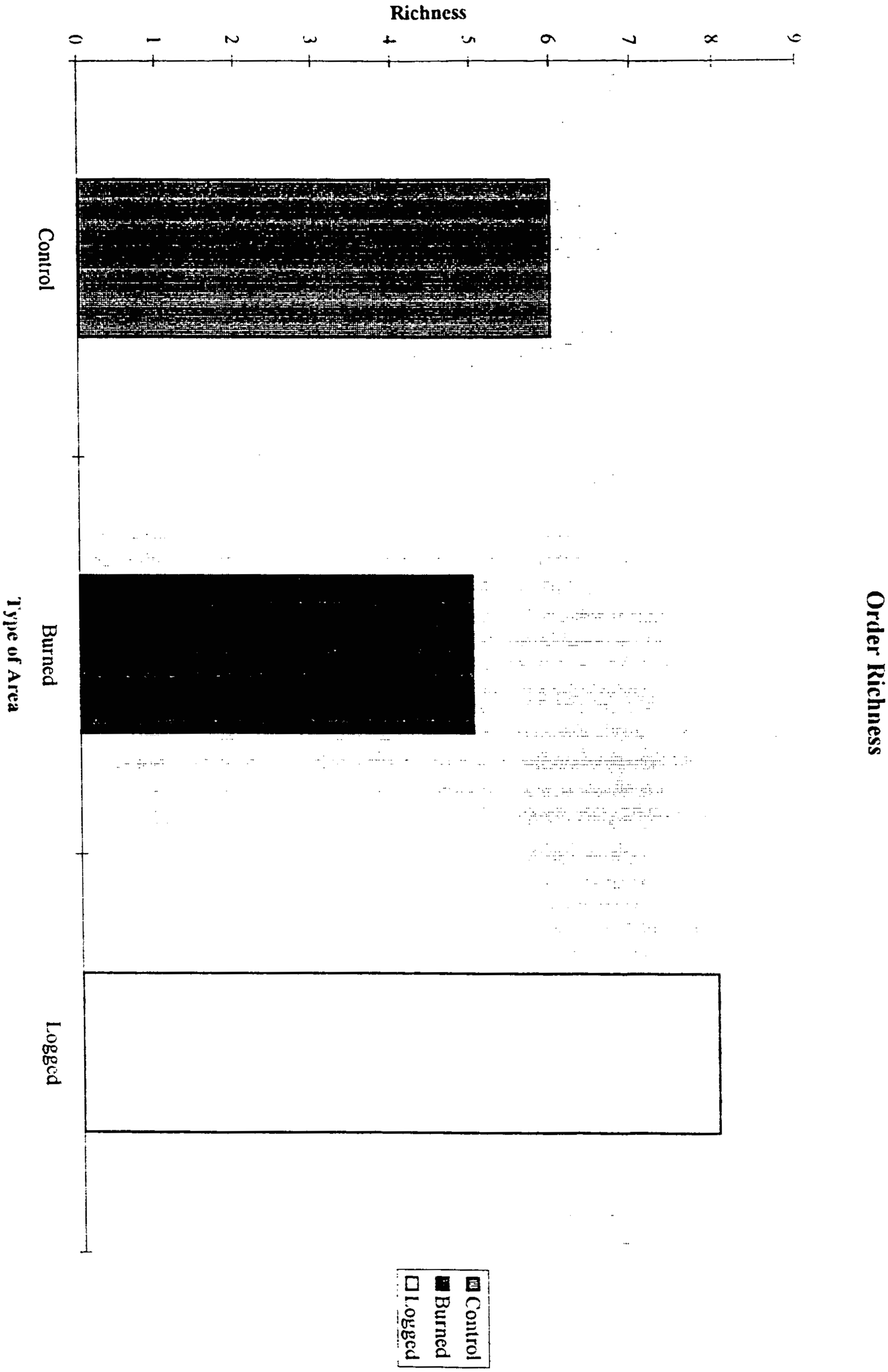


Figure 4

Number of Insects Found In Each Area

The Effects Of Fire and Logging On Insect Diversity In A Ponderosa Pine Forest, 1995



The Effects Of Fire and Logging On Insect Diversity In A Ponderosa Pine Forest, 1995