

INSECT RESPONSE TO THE 1988 FIRES
IN YELLOWSTONE NATIONAL PARK

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Objectives

- 1) Determine the types of alterations in insect communities that invade fire-altered habitats;
- 2) Through comparison of burned and unburned areas, determine those species which are eliminated or reduced in numbers and those species that are added or increase in numbers due to the effects of the forest fires of 1988; and
- 3) From the impressions gained in field work associated with this project, recommend study directions for future entomological/ecological studies.

Methods

A detailed discussion of methods are not included in this report. Descriptions will be found in manuscripts to be submitted for publication and presentations at conferences in 1990.

Research sites (nine unburned forest and nine forest fire sites, three unburned sagebrush and three burned sagebrush sites) were selected on a paired comparison basis. Sites were distributed throughout the park from just north of the south entrance of Yellowstone National Park and extending into the central western part up to just south of Mammoth in the northern portion of the Park.

Data satisfying the first two objectives was obtained by sampling each study site every 10 days beginning in early July. At each site, litter arthropods were sampled by collecting 10 0.25-m² litter samples; soil arthropods were obtained by coring 10, 15 cm deep soil samples; and plant arthropods were sampled by making 100 sweeps/site with a 15 inch sweep net. Fifteen pitfall traps per site were laid out in three transects to sample crawling arthropods.

Stand data (i.e., number of logs, tree density, seedling densities, standing dead tree densities and litter biomass) were gathered along belt transects in each study site to determine how habitat characteristics influenced arthropod responses for correlation with arthropod data. Soil and litter are being analyzed for nutrients and other variables by the Wyoming Soil Testing Service.

Data analysis is being accomplished by ecological parameter programs, ANVOA and regression analysis. A preliminary compartmental model will be constructed when sufficient information is available. At a later date, when successional data becomes available, a more detailed model is envisioned.

Results

At this point in time litter arthropod samples have been transformed and analyzed. One year after the Yellowstone fires, litter arthropod diversity, density and richness in both forest and sagebrush sites was lower than that found in adjacent unburned sites. (Tables 1 and 2) Insect species diversity, density and species richness was always lower than for other arthropods (i.e., spiders, mites, millipedes, centipedes and annelids).

Sagebrush

Generally, in unburned sagebrush there were fewer litter arthropod taxa than found in unburned forest sites. Lower diversity and densities were also found in unburned sagebrush than in unburned forest sites. Sagebrush sites contained more insect taxa than did forest sites. Overall, fires affected sagebrush litter arthropod composition to a much higher degree than it did forest sites.

Sagebrush litter arthropod species richness peaked in mid-to-late August in both unburned and burned sites with more species occurring in unburned sites. Species composition data showed fewer insect species occurring in both unburned and burned sites than other arthropods. There were weekly density fluctuations in both unburned and burned sites with greater fluctuations occurring in unburned sites. Unburned sagebrush litter arthropod diversity fluctuated every ten days. Diversity in burned areas tracked increases and decreases of arthropod populations after 20 days. Diversity generally increased as the season progressed in burned sites but decreased in unburned sites. Generally, species evenness was similar in both unburned and burned sites. Peak evenness

Table 1. Litter Arthropod Taxa Data.

Forest	
	Total Taxa
Taxa found in all sites	137
Taxa found in nonburned sites	127
Taxa found in burned sites	55
Taxa found only in burned sites	10
Taxa found more abundant in burned sites	2
Taxa found in both nonburned and burned sites	45
Noninsect arthropod taxa found in nonburned sites	72
Noninsect arthropod taxa found in all sites	77
Insect taxa found in nonburned sites	55
Insect taxa found in all sites	60
Sagebrush	
Taxa found in all sites	81
Taxa found in nonburned sites	60
Taxa found in burned sites	21
Taxa found only in burned sites	5
Taxa found more abundant in burned sites	0
Taxa found in both nonburned and burned sites	12
Noninsect arthropod taxa found in nonburned sites	48
Noninsect arthropod taxa found in all sites	52
Insect taxa found in nonburned sites	80
Insect taxa found in all sites	81
n =540 forest litter samples	
n =270 sagebrush litter samples	

Table 2. Changes in Litter Arthropod Density and Taxa Due to Fire.

Forest		
	(m ²)	(% Change)
Average insect density in unburned sites	154.7	
Average insect density in burned sites	19.4	87
Average noninsect arthropod density in unburned sites	222.7	
Average noninsect arthropod density in burned sites	74.1	67
Average number of insect taxa in unburned sites	18.2	
Average number of insect taxa in burned sites	6.1	68
Average noninsect arthropod taxa in unburned sites	27.8	
Average noninsect arthropod taxa in burned sites	10.6	63
Sagebrush		
Average insect density in unburned sites	63.3	
Average insect density in burned sites	4.7	95
Average noninsect arthropod density in unburned sites	346.0	
Average noninsect arthropod density in burned sites	58.0	86
Average number of insect taxa in unburned sites	17.0	
Average number of insect taxa in burned sites	1.7	99
Average noninsect arthropod taxa in unburned sites	43.3	
Average noninsect arthropod taxa in burned sites	8.3	83
n =540 forest litter samples		
n =270 sagebrush litter samples		

occurred, depending on the site, from late July to late August.

Forest

Mean forest arthropod densities varied widely between unburned sites; however, the variance of fluctuation is unknown as the data has not yet been analyzed statistically. There were large variations among sites, with peak densities occurring in mid-August on all sites. Peak arthropod densities also occurred in mid-August on burned forest sites. Litter arthropod diversity was generally greater and with lower fluctuations in unburned forest sites located in northern Yellowstone National Park. There were great fluctuations in diversity every 10 days in both unburned and burned sites in other parts of the park. Generally, fluctuations in species diversity were greater in burned sites than in unburned sites. Species richness generally showed small weekly fluctuations for forest litter arthropods, with more stability occurring in burned sites. Evenness of forest litter arthropod populations was generally greater in burned areas than in unburned sites. However, evenness in burned sites generally tracked increases and decreases of evenness in unburned sites.

General

Several biotic factors (analysis of abiotic factors are not complete) were significantly ($P < 0.05$) correlated with arthropod populations in unburned forest sites: 1) increased numbers of tree seedlings were correlated with decreased arthropod diversity, 2) increased density of trees ≥ 6 " diameter was associated with increased arthropod diversity, 3) higher densities of standing dead trees had lower arthropod diversities and 4) higher densities of logs were correlated with greater arthropod densities. Biotic factors significantly ($P < 0.05$) correlated with arthropod dynamics in burned forests included 1) sites with greater densities of tree seedlings had lower arthropod densities, 2) sites with more standing dead trees had higher arthropod densities but lower arthropod diversities, 3) sites with higher densities of logs had lower arthropod densities and diversities and 4) sites with higher litter biomass had greater arthropod population densities but lower arthropod diversities.

We have processed 540 forest litter and 270 sagebrush litter samples and 156 (out of 300) pitfall samples. Thus far, we have identified 137 forest litter arthropod species and 31 sagebrush arthropods species. Thus far, there are 58 forest

arthropod families and 32 sagebrush arthropod families taken from pitfall samples. There were 136,080 forest arthropod specimens and 28,800 sagebrush arthropod specimens extracted from the litter. Pitfall traps have produced 3120 forest arthropod specimens and 1026 sagebrush arthropod specimens.

Conclusion

Fires decreased, even after one year, litter arthropod density, diversity and richness in both forest and sagebrush habitats. Biotic factors such as the number of tree seedlings, the density of logs and standing dead trees and litter biomass affected arthropod population densities and arthropod species diversity in forest habitats in both unburned and burned sites.

Density, diversity, richness and evenness of arthropod populations in unburned and burned sites in forest and sagebrush ecosystems fluctuated weekly. Because only the litter samples have been analyzed, we can not make recommendations for future directions, especially in terms of park management.

Presentations, posters and manuscripts in preparation based on the data being obtained from the study.

Paper Presentation

Christiansen, T.A., R.J. Lavigne, and J.A. Lockwood. 1990. Impacts of the 1988 fires on species and trophic diversity of arthropods in Yellowstone National Park. Invited paper, Symposium of the Ecological Society of America, 1990 Annual Meeting, Snowbird, Utah.

Poster Presentation

Christiansen, T.A., R.J. Lavigne, and J.A. Lockwood. 1990. Arthropod community structure one year after the Yellowstone fires. Fire and the Environment: ecological and cultural perspectives. An international symposium. March 20-24, 1990. Knoxville, Tenn.

Papers In Preparation

Papers in preparation:

Arthropod litter communities one year after the 1988 Yellowstone fires. Environmental Entomology.

Biotic and abiotic influences on arthropod community structure in fire disturbed and nondisturbed forest habitat in Yellowstone National Park. Ecology.

Sagebrush and forest litter arthropod communities in Yellowstone National Park. Great Basin Naturalist.

Litter arthropod seasonal population dynamics in a temperate forest. Environmental Entomology.