Mormon cricket control in Utah's West Desert: Impacts on non-target arthropod communities and implications for vertebrate species of concern

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Abstract

In rangeland ecosystems of the United States, Orthoptera (grasshopper and cricket) populations can rapidly reach levels that are economically damaging to land owners. Consequently, insecticides are applied to suppress cricket and grasshopper populations and protect rangelands. A study conducted during the spring of 2005 investigated how the application of diflubenzuron may affect non-target arthropods inhabiting these areas. Three areas of Utah were sampled (Ibapah, Vernon, and Grouse Creek).

Comparisons of the terrestrial and aquatic arthropod community structure (abundance and species composition) were made among (1) sites treated with pesticides the previous year (Vernon and Ibapah), (2) sites treated with pesticides during the spring of 2005 (Grouse Creek), and (3) sites not treated with pesticides. Eight terrestrial sites were sampled in each of the three areas (four in treated area, and four in untreated area).

Terrestrial sites were dominated by Acari (mites), followed by Homoptera, Hymenoptera, and Coleoptera. Aquatic sites were dominated by zooplankton, followed by Ephemeroptera, Diptera, and Zygoptera. In addition to directly affecting aquatic and terrestrial invertebrate communities, pesticide use may have indirect impacts on vertebrate species (amphibians and birds) that rely on the invertebrate communities for food.

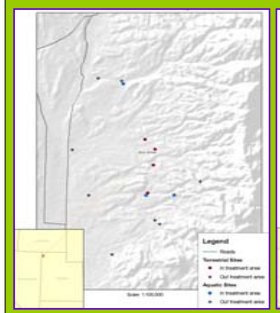
Background

Mormon cricket populations have persisted at economically damaging levels over the past 5-6 years in the West Desert of Utah. Consequently, control efforts for Mormon cricket outbreaks have been implemented in Utah's West Desert since 2002. The primary chemicals for control are carbaryl, applied as bran bait, and diflubenzuron, applied as an aerial spray. This study was designed to provide information on how non-target arthropods are affected by these pesticides treatments.

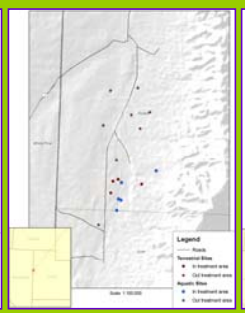
By examining changes in community structure of terrestrial and aquatic arthropods (abundance and species composition), this study will determine which taxa are affected and what the implications for vertebrates of management concern (amphibians and Sage Grouse) might be. We will evaluate the immediate affects as well as the residual or time-lag affects over the course of the insect maturation period.

Study Design

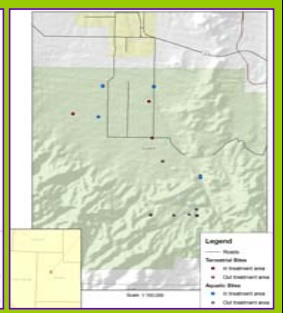
Based on available soil and vegetation maps, we stratified sites to pair treated and untreated zones within Mormon cricket infestation areas. Within each study site, terrestrial and aquatic invertebrates were sampled from uplands and water bodies (e.g., stream segment, spring, pond) in treated and untreated areas to compare arthropod community composition (abundance and species composition).



Grouse Creek Study Area



Ibapah Study Area



Vernon Study Area

Aquatic Invertebrates
We collected pre-treatment, two week post-treatment and 4 months post-treatment aquatic invertebrate samples from four treated and three untreated springs/streams at Grouse Creek. At Ibapah, we collected five aquatic invertebrate samples both inside and outside of the treatment area (one-year post spray). Four one-year post spray samples within the treatment area and five outside of the treatment area were collected at Vernon.

Terrestrial Arthropods
Grouse Creek was the only study area treated with pesticide in 2005. We established four transects in the Grouse Creek Mormon Cricket East Treatment Block (GC East), and four transects outside the treatment block to the west and south of the GC East. We sampled before pesticide application and within two weeks of application at each transect location. At Ibapah and Vernon, we sampled 60 traps at each of four transects in areas that had been treated with diflubenzuron in 2004, and from four transects that had not been treated previously.

Sorting terrestrial invertebrates

Preliminary Results

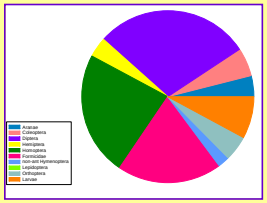


Figure 1: All Grouse Creek samples Sorted to date (209 samples)

A total of 1,920 terrestrial trap samples were collected. Three hundred and sixteen samples have been sorted to date. To reduce sorting time, we separated only the taxa that are most important as prey for Sage Grouse and/or amphibians (see Figure 1 for a list of orders).

The three transects represent samples from two pre-treatment transects from the treated area, and one transect from the untreated area (two weeks post-treatment).

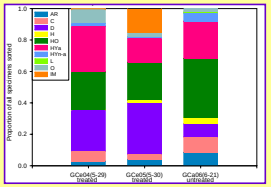


Figure 2: Proportional representation of the orders at the three transects with the most samples sorted

Insect life histories are classified as complete metamorphosis (holometabolous) and incomplete metamorphosis (hemimetabolous). Hemimetabolous larvae are ecologically similar to adults, active above ground, and exposed to diflubenzuron throughout their life cycle; larvae of holometabolous insects are often protected from diflubenzuron contact in nests or the soil. Diflubenzuron interferes with the molting process; adults are not affected. We predict that if there are effects of diflubenzuron application on non-target arthropods, we will find the greatest impact in hemimetabolous taxa.

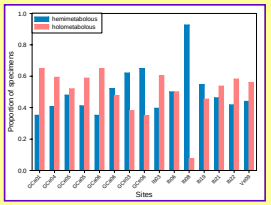
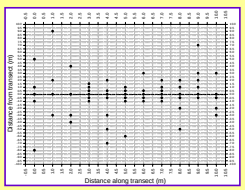


Figure 3: Proportion of specimens at each site with hemimetabolous (including spiders) or holometabolous life histories

Methods

Invertebrate Sorting
Invertebrates will be sorted to order and family and assigned to morphospecies. Estimates of morphospecies richness and relative abundance will be made. Taxa of particular interest (e.g., ants, beetles, and grasshoppers) will be identified to genus, and species if keys are available. Differences in abundance, or presence/absence of particular taxa that correlate with treatment patterns will be used to determine possible indicator species. Taxa will also be assigned to trophic and functional groups to assess potential ecological impact of pesticide treatment, and to assess resilience and resistance of these rangeland ecosystems to pesticide application.



Pitfall trap distribution

Pitfall traps with alternating funnel color

Sampling of Terrestrial Invertebrates
Terrestrial arthropods were sampled using pitfall traps. To provide an estimate of total invertebrate density, pitfall traps in each transect were arranged to meet the assumptions of DISTANCE sampling (that all invertebrates on the transect line are detected [i.e., caught], and that distances from the transect line are accurately measured). We used a transect pattern generated with WebSim (Lukacs 2001, 2002) that consists of 60 traps along 10 meter transects. Simulated invertebrate captures using this program provide density estimates with small confidence intervals. Traps were left open for three days, the contents were collected and the traps closed.

Aquatic invertebrate collection

Sampling of Aquatic Invertebrates
Aquatic invertebrates were collected from springs and streams in treated and untreated areas. At each sampling location, benthic samples were collected using a D-frame net. Water depth and substrate type were measured at each sampling location. Invertebrate species will be identified to the lowest practical taxonomic level. Estimates of species richness and relative abundance, and correlations with particular habitat types or features will be determined. Differences in abundance, or presence/absence of particular taxa will be used to determine possible indicator species.

2006/2007 Research

It is projected that the Grouse Creek area will be treated again in 2006. Therefore, we will collect terrestrial invertebrates at 12 new transect locations. There will be four transects outside of the treatment area and eight transects within the treatment area. Five water bodies within the treatment area and five water bodies outside of the treatment area will be sampled for aquatic invertebrates. Each of the twelve transects and ten aquatic sites will be sampled prior to pesticide treatment, two-weeks post treatment, 45 days post treatment and 90 days post treatment.

Water quality is another important component that will be tested in 2006 (unfortunately due to time constraints, this aspect of the study was not completed in 2005). At each of the ten aquatic sites, water chemistry will be analyzed to determine diflubenzuron and carbaryl concentrations.