IMPACT OF WATERSHED BURNING AND GRAZING ON RIPARIAN ARTHROPOD COMMUNITIES ALONG PONDS ON THE OKLAHOMA STATE UNIVERSITY RESEARCH RANGE

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CHAPTER I

INTRODUCTION

The crosstimbers ecoregion is a 17 million acre area between the eastern deciduous forests and tallgrass prairies of the Great Plains (Oklahoma Forestry Services). This ecoregion is typified by hardwood forests consisting of post oak (*Quercus stellata*), blackjack oak ***(****Quercus marilandica)*, and eastern redcedar (*Juniperus virginiana*) mixed with tallgrass prairie plants like little and big bluestem (*Schizachyrium scoparium and Andropogon gerardii)* and Indiangrass (*Sorghastrum nutans*) (Engle, et al., 2006; Oklahoma Agricultural Experiment Station). The landscape of the cross-timbers is dotted with man-made ponds and much of the area is used for grazing cattle and subject to controlled burning regimes. This study focuses on invertebrate communities inhabiting the riparian zones of these ponds and how they are affected by management practices common to the cross timbers. Following watershed burns of rangeland ponds with and without the inclusion of a vegetative buffer, the response of riparian arthropods was observed. Following the Flood Control Act of 1944 and other public laws, the Natural Resources Conservation Service (NRCS) established dams and ponds, throughout much of the cross-timbers habitat in Oklahoma, with the goal of addressing watershed-related issues (Public Law 78-534). Issues addressed include flooding, water quality, and animal waste management (Oklahoma Conservation Commission). The Oklahoma State University Cross-timbers Experimental Rangeland (CTER), located southwest of Stillwater, OK, consists of approximately 5000 acres of cross-timbers habitat, interspersed with over 40 of these watershed management ponds (Fig. 1; Oklahoma Agricultural Experiment Station).

Rangeland ponds, created within CTER following the Flood Control Act of 1944, serve in a number of capacities. In addition to their intended purpose of watershed management, they also provide water and habitat for cattle and a diverse assemblage of wildlife that inhabit the rangeland. These ponds also serve as a habitat for invertebrates in and around the aquatic and terrestrial ecosystem of the pond. A dynamic food web exists between aquatic and terrestrial communities, a relationship that is vital to the overall health of the ecosystem (Baxter, et al., 2005; Burdon and Harding, 2008; Paetzold, et al., 2005; Nakano and Murakami, 2000). Arthropods within the riparian zone play an important role in the food web and the interface between aquatic and terrestrial communities. Fish and other aquatic organisms depend on the input of terrestrial arthropods for their diet (Baxter, et al., 2005). This occurs when terrestrial arthropods fall or drop into aquatic systems (Merritt and Cummins, 1996). In contrast, terrestrial predators such as spiders and beetles rely on emergent aquatic insects for a large percentage of their diet (Hering and Plachter, 1997; Sanzone et al., 2003; Marczak and Richardson, 2007; Paetzold, et al., 2005).

Known as a transitional region between prairie and forested low hills, the cross-timbers ecoregion is not as arable or suitable for crops as other plains ecoregions (Environmental Protection Agency). In recent years, the practice of fire suppression has led to an increase in overall forest density and has caused eastern redcedar (*Juniperus virginiana*) to dominate the landscape (National Health and Environmental Effects Research Laboratory). Range management practices such as section burning are implemented to remove biomass, enhance forage, stimulate plant growth, and increase habitat diversity (Stubbendieck, et al., 2007; White and Hanselka, 1989). The burn regime at the OSU-RR differs based on section. Sections within the rangeland were divided, therefore variation in rotation and timing occurred between patches. Burn rotations of 2, 3, and 5 years were used in both the spring and summer for all areas within the rangeland. One regime characteristic that did not differ was patch versus watershed burns; all burns at the OSU-RR were patch burns (Fig.1). Despite best efforts to limit this, indirect effects are often observed.

Disturbances due to these practices have been found to influence aquatic and/or terrestrial arthropods. Changes to either of these communities may influence the overall health of the riparian zone. As a method to limit disturbance to riparian areas, vegetative buffers are often used. Riparian buffers are implemented to limit disturbance, and may help to mitigate some of the impacts of burning on the aquatic and riparian communities (Naiman and Décamps, 1997). The use of vegetative buffers has been found to reduce the amount of sedimentation and nitrification that occurs in rangeland ponds (Mayer, et al., 2006)

Following a controlled burn of a pond's watershed with and without the inclusion of a vegetative buffer, changes in the riparian arthropod communities occur. These changes are important when examining the interaction between aquatic and terrestrial arthropod communities and may impact either or both adjacent systems. By observing the relationship between the riparian system and the associated range management practices, better decisions may be made. Within this ecosystem, a variety of blood-feeding flies utilize ponds, surrounding wetlands and ephemeral pools as oviposition sites.

Cattle grazing in these areas may be impacted by biting flies, depending upon conditions and fly abundance. Blood-feeding flies from the families Culicidae, Simuliidae, and Tabanidae emerge as adults from freshwater systems to feed on terrestrial vertebrates such as grazing cattle. The blood-feeding activity of the flies influences grazing cattle by limiting weight gain. During a three year study, stable flies *Stomoxys calcitrans (L.)* (Muscidae) in Nebraska were found to decrease weight gain by 0.2 kg/day in unsprayed cattle. Although Muscidae are not aquatic during any of their life stages, the decreased weight gain caused by them would be anticipated with other blood-feeding flies. Following permethrin sprays three times weekly, treated cattle were found to have an average weight gain (over three 28-day periods) of 1.12 kg/day, while control cattle had an average of 0.92 kg/day (Campbell, et al., 2001). The influence seen on grazing cattle due to biting flies helps to demonstrate the importance of the predatory relationship between riparian spiders and beetles and blood-feeding flies. Spiders in riparian areas may effectively limit populations of blood-feeding flies. In cage exclosure studies on rice fields in Japan, spiders have been found to reduce *Culex tritaeniorhynchus Giles* (Diptera: Culicidae) survival to ten percent within four days of introduction, as compared to sixty percent survival on fields without predators (Takagi, et al., 1996). Without the predation pressure from terrestrial predators emergent blood-feeding flies are more likely to emerge in larger numbers, thus causing stress to cattle (Riechert and Lawrence, 1997).

The primary objectives of this study were to:

Characterize riparian arthropod communities in ponds that are subjected to rotational watershed burning at the levels of abundance, diversity and community composition.

Evaluate the differences in riparian arthropod communities in ponds that are subjected to rotational watershed burning with and without a 10 meter riparian buffer because of the importance of arthropods within the riparian zone, changes observed due to section burning and grazing may influence the ecosystem and the organisms within it.

CHAPTER II

REVIEW OF LITERATURE

Rangeland in the crosstimbers ecoregion of Oklahoma is often subject to a regime of rotational controlled patch-burning to stimulate growth of forage for cattle and to control pest species of plants. Effects of cattle grazing and rotational burning have been studied in the terrestrial rangeland but the ecology of the ponds and their corresponding riparian zones have received little attention. This study focused on the arthropod community that inhabits the riparian zones of these rangeland ponds and how they respond to burning and grazing by cattle. The results of this study may provide some baseline information about this community which provides an important interface between the aquatic and terrestrial systems of the crosstimbers rangeland system.

The pastureland system

The Oklahoma State University Research Rangeland (OSURR) is 10 miles west of Stillwater, Oklahoma and is located in the crosstimbers ecoregion (Oklahoma Agricultural Experiment Station, 2010). This is the largest ecoregion in Oklahoma and is composed of native prairies, forests and woodlands, and was originally formed through the use of interval burning and grazing (Engle, et al., 2006). The OSURR operates using a three year rotation of patch burning on all ponds (Figure 2), with the exception of the two reference ponds, which have not been burned since the establishment of the OSURR (at least 20 years).

Cattle are grazed continuously at a rate of 17 acres/head in the regions surrounding all ponds except one reference pond (ENTO).

Composed mainly of trees such as post oak (*Quercus stellata*), blackjack oak *(Quercus marilandica)*, and eastern redcedar (*Juniperus virginiana*), this ecoregion is primarily used as pastureland (Oklahoma Forestry Services). Other vegetation within this ecosystem includes grasses like little and big bluestem (*Schizachyrium scoparium and Andropogon gerardii)*, as well as Indiangrass (*Sorghastrum nutans*) (Engle, et al., 2006). Terrestrial habitats in the ecoregion are comprised mostly of rangeland. It is a heterogeneous landscape composed mainly of grasslands and Oak thickets interspersed with shrubby habitats.

Within the cross timbers ecoregion are numerous man-made ponds and lakes. These lentic systems are inhabited by many organisms, including zooplankton, rotifers, macroinvertebrates, fish, and reptiles and amphibians (Paukert and Willis, 2003). Aquatic macroinvertebrates have been extensively studied due to their abundance, long life cycles, and low motility (Bass, 1994; Merritt and Cummins, 1996). In addition, because aquatic macroinvertebrates usually remain in the same aquatic system, they usually show an accurate representation of the changes seen within the environment (Barbosa, et al., 2001).

Insects are prevalent within lentic systems, some being fully aquatic while others may only have an aquatic larval stage. Aquatic insect orders commonly found in rangeland ponds include Diptera, Coleoptera, Hemiptera, and Odonata (Paukert and Willis, 2003). Lentic systems are also a breeding ground for blood-feeding flies, such as Tabanidae, Ceratopogonidae, and Culicidae (Nielsen, et al., 1986).

Arthropods are also common in areas surrounding freshwater system, called the riparian zone. This zone is an important ecosystem that provides food, shelter, and reproduction to aquatic and terrestrial arthropods. Many riparian arthropods are both terrestrial and aquatic at different life stages. This type of life history means that these organisms represent an important interface between adjacent aquatic and terrestrial habitats (Erman, 1981; Merritt and Cummins, 1996). This interaction between ecosystems creates a complex community that closely ties both ecosystems together.

Riparian interface

Riparian food webs represent complex communities of aquatic and terrestrial organisms. Within these communities exists a dynamic food web in which organisms in both adjacent aquatic and terrestrial ecosystems prey upon organisms from the other (Baxter, et al., 2005; Paetzold, et al., 2005; Nakano and Murakami, 2000). While both aquatic and terrestrial food webs are frequently studied independently, the importance of the relationship between the two is not well understood.

Aquatic and terrestrial arthropods essentially become reciprocal subsidies to organisms in each individual ecosystem (Nakano and Murakami, 2000). Trophic relationships occur in riparian ecosystems among fish, birds, lizards, arthropods, and other organisms (Baxter, et al., 2005; Nakano and Murakami, 2000). This relationship between systems demonstrates an interdependence that is vital to the health of the riparian ecosystem (Baxter, et al., 2005). Should a disturbance such as burning influence the amount of arthropods (subsidy) available, it can be inferred that the health of the ecosystem would decline.

For example, terrestrial invertebrates comprise up to 50 percent of fishes' diets and during the summer months, up to 86 percent of their diet (Baxter, et al., 2005). In addition, riparian arthropods have been found to consume up to 40 percent of the total aquatic insect emergence in river systems (Paetzold, et al., 2005). Aquatic insects were also found to compose 48 and 56 percent of the diet of two lycosid spiders, *A. cinerea* and *P. waglieri* (Paetzold, et al., 2005).

Riparian arthropod communities

Arthropod communities in riparian ecosystems consist of many taxa. Within these communities are arthropods that occupy different niches and roles within the ecosystem. Three main taxonomic groups of interest were the focus of this study: Araneae, Coleoptera, and Diptera. These three groups are all commonly found throughout the riparian ecosystem and play important roles within it.

Spiders

These arthropods are generalist predators and help to regulate populations of pest species of insects. For example, on Texas cotton fields, lynx spiders have been found to consume up to 34 species of insects in 21 families and nine orders (Maloney, et al., 2003). The ability to feed on a variety of organisms makes them versatile and limits the impact disturbance may have on their population. In addition, riparian spiders have been shown to effectively limit populations of emergent blood feeding flies. For example, in cage studies, spiders reduced emergent *Culex tritaeniorhynchus* survival to ten percent within four days of emergence, as compared to sixty percent in cages without Lycosid spiders (Takagi, et al., 1996).

Emergent aquatic insects compose a significant portion of spiders' diets (Sanzone et al., 2003; Marczak and Richardson, 2007; Paetzold, et al. 2005). Specifically, within riparian zones, free-living spiders gained 68 % if their carbon from predation on emergent insects, and some web-weaving spiders obtained 100 % (Sanzone et al., 2003; Baxter, et al., 2005). Web-building spiders have also been found to inhabit shoreline areas more commonly, with an inverse mean web-density observed as distance from shore increases (Burdon and Harding, 2008). The preference for shoreline areas coupled with their reliance on emergent aquatic insects demonstrates the overall importance of the riparian system to riparian spider populations.

Because of this, changes in either aquatic insect or spider abundance may lead to increased herbivory upon riparian vegetation (Baxter, et al., 2005). For example, in pastureland in Tennessee, spider assemblages were enclosed in screened-in compartments to prevent predation. Areas surrounding spider enclosure cages had little predation pressure, and responded with significantly higher pest species abundance than on any other treatment (Riechert and Lawrence, 1997). What this indicates is that following a reduction or absences of spider populations, pest species are under less predation pressure. This would likely lead to an increase in herbivory by pest insects.

In addition to increases in herbivory, disturbances such as burning also affect spider communities. On unburned reference sites within riparian zones of the crosstimbers rangeland, a well-established arthropod community exists. Because of their mobility or dwelling in burrows, many spiders survive fires. Due to a lack of prey options during the shock phase following disturbances, spiders may vacate the area (Nagel, 1973; Warren, et al., 1987). This emigration of spiders also occurred during periods where prey was absent. Horizontal orb weaver abundance was 57 percent lower at exclosure sites (a greenhouse like cover over stream sections that prevented emergent insects from escape, and prevented spiders from preying on emergent insects) than at control sites (Marczak and Richardson, 2007). Remaining spiders on burned areas may be affected long term. Following spring burns on Kansas grasslands, burned plots displayed a significantly lower mean Araneae weight than unburned plots (0.114 and 0.131 g) (Nagel, 1973). Significant reductions were also seen in spider abundance following autumn and spring burns on Wisconsin prairie and Idaho grassland (Warren, et al., 1987). In contrast, Lycosidae were more abundant in areas that had been burned recently compared to sites that had never been burned (Warren, et al., 1987). This contrasting trend is believed to occur due to burrowing behavior exhibited by Lycosidae, which enables them to survive a burn event, and immediately feed on prey species following the disturbance (Warren, et al., 1987).

Beetles

Other taxa, such as members of the insect orders Coleoptera and Diptera also maintain important interactions within the riparian ecosystem. Hering and Plachter (1997) reported that certain species of aquatic invertebrates composed up to 73% of the diet of riparian-inhabiting Carabidae. Staphylinid beetles inhabiting riparian areas also have been found to rely on emergent aquatic insects for a majority of their diet (up to 80%) (Paetzold, et al., 2005). Although emergent aquatic insects comprise a large percentage of Coleoptera diet, other organisms, including herbivorous pest insects are also preyed upon. Through predation, Coleoptera have shown the ability to limit or reduce pest species abundance. Snyder and Ives (2001) found that carabid beetles were able to reduce aphid density in short grass areas by fifty percent over a seven-day period. These predatory beetles, are generalist predators, have been found to be effective in limiting pest species such as aphids (Snyder and Ives, 2001). They did discover though, that as plant height increased, the influence of carabid beetles on aphid densities decreased. Because carabids are usually large beetles, they were not physically able to climb high enough to reach the aphids on taller plants.

Flies

Blood-feeding flies in the families Culicidae, Ceratopogonidae, Simuliidae, and Tabanidae emerge as adults from freshwater systems and subsequently blood-feed on terrestrial vertebrates such as cattle, horses, and humans. These flies may negatively impact livestock populations as "nuisance pests" by interfering with weight gain in cattle, and serving as vectors of pathogens and transmit diseases to humans and livestock. Blood feeding flies in riparian areas feed on cattle grazing in the area. In a three-year study, Campbell, et al. (2001) found that Muscoid flies reduced weight gain of cattle by 0.2 kg per day which resulted in a 16.8 kg/steer reduction when compared to cattle that were sprayed with pesticide sprays to prevent feeding by flies. Although most Muscidae do not contain an aquatic life stage, similar results with emerging aquatic blood-feeling Diptera would be expected. Despite this, management practices have been found to limit the emergence and abundance of blood feeding flies on grazing cattle.

Changes seen in the abundance of Dipterans were usually dependent upon larval feeding type. Predaceous larvae, such as bee flies and small-headed flies were more abundant on unburned than burned plots (Warren, et al., 1987). The reduced abundance in burned plots may be attributed to a lack of prey items. In contrast, Diptera were more abundant following a burn event than before, upon recovery of the system (Barratt, et al., 2006). This change in abundance was likely dependent upon feeding regime (Warren, et al., 1987). Phytophagous larvae, including Anthomyiid and flower flies were also more abundant on burned plots.

Functional feeding groups

Arthropod communities in riparian areas are composed of many types of insects and other macroinvertebrates. Based on physiological differences, as well as the niche each organism has within the environment, different feeding strategies arise. Each riparian feeding strategy is based on both environmental and physiological factors, and help to make up the riparian food web. Many riparian arthropods transcend the division between aquatic and terrestrial niches by inhabiting different systems at different life stages. Because of this unique role of connecting aquatic and terrestrial ecosystems a wide range of both terrestrial and aquatic feeding strategies are represented (at different life stages) within riparian arthropod taxa. Adult terrestrial stages of riparian arthropods exhibit three main feeding strategies: phytophagous (plant eaters), zoophagous (insect eaters), and saprophagous (detritivores) (Borror, et al., 1989). Aquatic immature stages of riparian arthropods include predators (engulfers, piercers), herbivores (collectors, scrapers, shredders), and omnivores (Environmental Protection Agency, 2010).

Herbivores

Riparian herbivores are generally specialized, with each specific taxa feeding on a specific plant or part of a plant (Borror, et al., 1989). There are three types of specialization related to feeding. Monophagous arthropods are the most specialized, and only eat one type of food. Arthropods that have a diet restricted to few types of specific food are referred to as oligophagous, while polyphagous arthropods consume a wide spectrum of food.

Due to the sheer volume of herbivorous insect taxa, almost no plant is spared from herbivory. Within this group are pest species, which feed upon crop plants, or other beneficial plant species. These pest taxa are able cause damage to crops or forests on a large-scale. Representatives of this group that were collected in this study include adult Aphididae, Auchenorryncha, and Curculionidae (Borror,et al., 1989). Borror et al. 1989) grouped herbivorous arthropds into six main groups classified by their feeding habit: leaf chewers/feeders, sap feeders/stem borers, gall producers, root-feeders and "fungus growers" (Borror, et al., 1989).

Leaf chewing insects feed on foliage by physically eating leave of plants. This often leaves plants devoid of leaves or vascular tissue. Abundant leaf chewers can defoliate large sections of cropland or forests. Adult Orthoptera, Coleoptera, and larval Lepidoptera are all examples of leaf chewing insects.

Another method of herbivory for arthropods is sap sucking. These organisms pierce the plant and either feed on the xylem or plant eggs within the plant. This often damages the vascular tissue and may ultimately kill the plant. Examples of this are Aphididae, Coccoidea, and Auchenorrhynca (Borror, et al., 1989). Similar feeding regimes include stem borers, who bore into live trees and plants for food and reproduction. This often results in stunting and death to affected plants. Examples of this functional feeding group include adult Formicidae, Buprestidae, and Cerambycidae (Borror, et al., 1989). Moths and larval insects of this functional feeding group mainly burrow into fruits and other crops (Borror,et al., 1989).

Other terrestrial feeding groups include gall producing insects which inject chemicals into plants which cause abnormal growths in which the arthropod resides. Examples include Acari, Coleoptera, Diptera, Hemiptera, Hymenoptera Lepidoptera and Thysanoptera, Root feeders live in the soil and feed on underground parts of plants. Numerous examples are found in Coleoptera. Finally, “fungus growers” occur in Coleoptera and Hymenoptera (Borror, et al., 1989).

Herbivorous arthropods in riparian ecosystems maintain several roles within the food web. First of all, these arthropods are food for higher level consumers, such as spiders or other predators. In addition, many are also pests to crops and other plants. Herbivorous arthropods also help in the pollination of other plants and the dispersal of seeds (Merritt and Cummins, 1996).

Predators and Parasitoids

Insects such as Ichneumonid and Eucoilid wasps, which rely exclusively on one or a small group of taxa as prey, are called specialist predators (Fraser, et al., 2008; McKenzie and Richerson, 1993). Specialist parasitoid wasps are widespread, abundant organisms that compose up to 25% of all insects in some ecosystems (Fraser, et al., 2008). Parasitoid females lay their eggs on or inside the host species. As their development continues, the larval wasps feed upon the host organism’s organs and body fluids until they emerge from the host as adults (Hoffman and Frodsham, 1993). Usually, this type of parasitism ultimately kills the host insect upon the emergence of larvae.

Specialist predators tend to show a density-dependent response to outbreaks of pest species of insects. Because parasitoids and most of their prey have short generation times, outbreaks occur quickly; as pest species populations increase, parasitoids can be rapidly produced. But because parasitoids are able to parasitize multiple hosts within a short period of time, density control of the pest species occurs within the ecosystem.

Generalist predators are arthropods that have little to no specificity when it comes to prey (Riechert and Bishop, 1990). Generalist predators have been shown to eat whatever they are able to catch, thus they are relatively unaffected by fluctuations in the abundance of prey species (Snyder and Ives, 2001). All of these organisms are able to feed on a wide variety of insects, mollusks, seeds, and even some small vertebrates (Snyder and Ives, 2003).

Several factors influence the ability of generalist predators to catch and eat their prey. Not only does plant height influence what predators are able to prey upon, but the relationship between the size of the predator and prey are influential as well. Larger predators are able to eat a wider range of organisms than smaller predators (Memmott, et al., 2000). These insects have been shown to be effective methods for control of pest species, such as aphids. In addition, predators are also able to limit the emergence of blood-feeding insects from aquatic systems (Takagi, et al., 1996).

Detritivores

The plant litter, decaying plant and animal matter found throughout the riparian ecosystem are utilized by insects called saprophagous insects. Not only is this matter used as a food source itself, it also attracts organisms that lay their eggs on/within the matter (Calliphoridae) or fed on other organisms near the carrion (Staphylinidae) (Borror, et al., 1989). Other examples include adult Blattaria, Isoptera, Silphidae, Muscidae, and Scarabaeidae (Borror, et al., 1989). Detritivores are vital when it comes to the breakdown of organic matter, and help facilitate the degradation and decay of animal and plant matter.

Aquatic Functional Feeding Groups

Many insects in larval stages emerge from the aquatic environment and are terrestrial as adults. This interrelatedness between aquatic and terrestrial ecosystems demonstrates how important the health of each individual system is. Aquatic stages of riparian arthropods include six main functional feeding groups: predators, piercers, omnivores, collectors, scrapers, and shredders (Environmental Protection Agency, 2010).

Predators-Engulfers

Within aquatic systems are many predators which feed specifically upon a certain taxa, or groups of taxa. Predatory organisms may be specialized and focus on one or a small group of taxa, or generalized, feeding upon whatever is available. Predators in aquatic systems include larval Odonates, Anythomyiidae, Ephemeridae, and adult Gyrinidae (Merritt and Cummins, 1996). These organisms help to limit herbivorous arthropod abundance in aquatic systems. By doing this, the amount of herbivory to aquatic plants would be limited. In addition, engulfers also prey upon larval blood-feeding flies, which would limit their emergence. Although most aquatic predators are not aquatic as adults, some Hemiptera and Coleoptera (including Gyrinidae) are predatory as adults.

Predators-Piercers

These predatory organisms consume other organisms by piercing the tissues of their prey. By using special mouthparts, they are able to suck up body fluids of prey insects (Merritt and Cummins, 1996). Included in this group are many adult Hemipterans including Nepidae and Belostomatidae (Borror, et al., 1989; Environmental Protection Agency, 2010). Piercers maintain a similar role to that of the engulfers, preying on other aquatic insects and limiting the emergence of pest insects (including blood-feeders).

Omnivores

Omnivores are generalist feeders that can eat both live organisms and other organic matter. This versatility allows them to tolerate disturbances (Environmental Protection Agency, 2010). Following a disturbance, if live organism abundance is low, omnivores can consume vegetation or other organic matter and conversely if there is little vegetation; they can prey primarily upon live organisms. Examples include species within families such as adult Haliplidae and Gyrinidae (Merritt and Cummins, 1996). Within the aquatic ecosystem, omnivores are important consumers. Should a primary predator leave following a disturbance, these organisms may be capable of taking over the role of predator. This is vital, as a lack of predators in the ecosystem may cause an overabundance of herbivorous arthropods. It should also be noted that omnivorous arthropods are primarily adults.

Collectors

Insects such as larval Hydrophilidae, Tipulidae, and adult Corixidae include some species that collect and feed on leaf fragments or particulate matter (Merritt and Cummins, 1996; Environmental Protection Agency, 2010). This group can also be divided into two smaller divisions. Filtering collectors feed on matter suspended within the water column, while gathering collectors actively search for organic matter to consume. Each group in vital to the health of the aquatic ecosystem. These arthropods consume leaf matter and other nutrients, or filter out particulate matter within the system. This helps limit the amount of organic matter within the system.

Scrapers

Scrapers rely on periphyton, a mix of algae, bacteria, and microbes that often covers the surface of substrates within the pond, as a method for feeding (Environmental Protection Agency, 2010). Adult Elmidae, Hydroscaphidae, and larval Canacidae are all taxa that rely on these organisms for feeding and exhibit mouthparts adapted to scraping substrate (Merritt and Cummins, 1996). Organisms in this group provide forage for predators, as well as cleaning periphyton from different substrates within the aquatic ecosystem.

Shredders

Shredders primarily consume coarse organic matter, including leaves (Environmental Protection Agency, 2010). This group feeds upon course particulate organic matter (CPOM), and by feeding on it, changes this into fine particulate organic matter (FPOM). Larval Chironomidae, Tipulidae, and Hydrophilidae as well as others all help in the creation of FPOM (Merritt and Cummins, 1996). The role that shredders play in aquatic systems is the conversion of CPOM into FPOM. Aquatic insects are capable of consuming more than their body weight each day, so a significant amount of waste is generated every day. By breaking down this CPOM, shredders are able to contribute to the food resource base of collectors (Cummins, et al., 1989).

Differences in functional feeding groups are seen at any taxonomic level. All taxa within an order may contain the same functional feeding group, or differences may occur within a genus or species (Merritt and Cummins, 1996). In addition, due to the different feeding methods, different groups may be more sensitive to disturbance than other taxa. More sensitive taxa may include specialized feeders such as scrapers, piercers and shredders (Environmental Protection Agency, 2010; Rawer-Jost, et al., 2000). Increased sensitivity by these groups may be attributed to their specialization. Their reliance upon a smaller subset of available prey limits their ability to adapt should their prey disappear. In contrast, generalist functional feeding groups, including gatherers and filterers, and some predators, are more tolerant to pollution (Rawer-Jost, et al., 2000).

Potential impacts of pastureland management on riparian arthropod communities

Rangeland ecosystems in general are used primarily for grazing cattle. As such, they are managed to obtain increase weight gain in cattle through improved grass palatability, quality, and yield as well as reduce the presence of trees and invasive or undesireable plants. (Stubbendieck, et al., 2007). Prescribed section burning and vertebrate grazing are tools used to improve forage, plant yield, habitat diversity, as well as stimulate new plant growth (Stubbendieck, et al., 2007; White and Hanselka, 1989). In addition, section burning is used to help control the prevalence and abundance of trees and invasive or non-native species of plants (Stubbendieck, et al., 2007). While management practices are useful in controlling pest species of plants, land use practices have been shown to impact riparian macroinvertebrate communities (Paukert and Willis, 2003; Nielsen, et al., 1986; Mellon, et al., 2008). These disturbances often cause significant changes to the arthropod community that may be evident at the levels of community composition, species richness and diversity, and abundance (Barratt, et al., 2006).

Following a burn event, changes to aquatic and terrestrial arthropods communities can remain for years following the disturbance. Areas that are burned consistently are more able to recover, while areas that are burned rarely take much longer to get to normal or enhanced productivity and biodiversity levels. Effects from this disturbance may be seen for five to ten years following the burn (Bowman and Boggs, 2006). Arthropod density was found to recover quickly following a fire, but taxa richness and community composition was affected for up to six years following the disturbance (Bowman and Boggs, 2006). Changes in species composition are also seen in macroinvertebrates and insects for up to one year following a burn event (Bowman and Boggs, 2006). Barratt, et al., (2006) found that following a burn event; results can be seen in the microarthropod community for up to 26 months.

Land use practices related to pastureland management result in both abiotic and biotic impacts on both adjacent ecosystems and the organisms inhabiting them for long periods of time (Bowman and Boggs, 2006; Barratt, et al., 2006). An increased nutrient load due to burning causes sedimentation in pastureland ponds, which influences both the physical water chemistry and biological function of the ponds (Barbosa, et al., 2001; Paukert and Willis, 2003; Nielsen, et al., 1986; Mellon, et al., 2008; Bass D., 1994). Physical water quality parameters including temperature, phosphorous levels, dissolved oxygen, pH, mean lake depth, and conductivity influence species richness, diversity and abundance of aquatic macroinvertebrates (Bass D., 1994). Biotic factors, such as chlorophyll levels, and emergent and submergent vegetation coverage also influence aquatic invertebrate community composition (Paukert and Willis, 2003). Any disturbance within the aquatic system of rangeland ponds effects not only the vegetation and organisms within it, but the entire terrestrial system as well.

For example, Chironomidae and Ceratopogonidae were found to have a more significant relationship with a higher shoreline development index (SDI) (an index of regularity for ponds, indicating a less round, more shallow pond), lower Secchi depth (increase in turbidity), and emergent vegetation coverage (Paukert and Willis, 2003). Other fly larvae (Simuliidae) were more prevalent in slightly-to-moderately polluted water, while slightly-to-strongly polluted waters were favorable breeding grounds for Culicoides larvae (Nielsen, et al., 1986).

While disturbances in a riparian system affect all arthropods within the system, certain taxa respond more quickly than others. Responses within a given order differed based on feeding regime; with several changes observed (Warren, et al., 1987). Diptera were found to generally be more abundant following a burn event than before, upon a recovery of the system.

Changes seen in the abundance of Dipterans were usually dependent upon larval feeding type. Predaceous larvae, such as bee-flies and small-headed flies were found to be more abundant on unburned than burned plots (Warren, et al., 1987). In contrast, larvae that were phytophagous, including Anthomyiid and flower flies were more abundant on burned plots. Other insect groups found to be more abundant following burns include blister (Meloidae) and rove beetles (Staphylinidae), as well as pest species of Hemiptera (Warren, et al., 1987; Reed, 1997). Responses by Meloidae and Staphylinidae were likely based on feeding regime (Borror, et al., 1989). Both families are generally predatory, so recolonization by prey species of these two groups may influence their return.

In studies focused on the effects of burning on spider taxa, different spider taxa tend to respond differently to controlled burns. Lycosidae were found to be more abundant in areas that had been burned recently as compared to sites that had never been burned (Warren, et al., 1987). In contrast, significant reductions in surface-dwelling spider abundance were observed following autumn and spring burns on Wisconsin prairie and Idaho grassland (Warren, et al., 1987).

Indirect effects on riparian habitats due to watershed burning are also seen. Elevated bacterial and fungal populations, as well as changes to soil chemistry, moisture, and temperature are observed following a burn event (McCullough, et al., 1998). Changes in the soil and plant community occur due to burning, and this ultimately influences the insect community. Ultimately, these changes to all parts of the riparian ecosystem influence the energy flow observed between aquatic and terrestrial ecosystems.

Allochthonous input from one system to the other causes changes in predation patterns. In both aquatic and terrestrial habitats, *in situ* prey was found to be positively affected by the input from the corresponding habitat (Baxter, et al., 2005). Emergent aquatic insects in riparian habitats caused increased predation pressure by spiders. The predation of emergent insects by spiders caused a decrease in herbivory on riparian plants (Baxter, et al., 2005).

Riparian buffers

Vegetative or riparian buffers are an area or defined distance from a water body that has land use restrictions to help limit disturbance in the aquatic system and surrounding riparian area (Naiman and Décamps, 1997). The use of this management practice is commonly recommended on rangeland ponds to help prevent excessive disturbance to the ecosystem following a watershed burn. This management practice is implemented to limit the effect of erosion and sedimentation following a burn (Naiman and Décamps, 1997). Riparian buffers have also been found to reduce surface-level nitrogen and phosphorous levels within freshwater systems (Mayer, et al., 2006). In addition, they may also limit the effects of disturbance upon terrestrial macroinvertebrates, as this unburned area provides a refuge for insects and other arthropods. Vegetative buffers may also provide necessary food for herbivorous arthropods immediately following a burn of the pond's watershed (Nagel, 1973).

Cattle's grazing also indirectly impacts the arthropod community. Vertebrate grazing in the areas surrounding ponds may have several negative effects on not only the insect community, but the overall health of the ecosystem. Aside from the physical effects of trampling and vegetation removal, waste from these animals is introduced into the aquatic system. This waste decreases overall dissolved oxygen levels, increases biological oxygen demand, and increases bacterial loads (Kaller and Kelso, 2006). The effect of animal waste inputs on the aquatic insect community is significant. Arimoro and Ikomi (2008) found that sites with inputs of feces from vertebrates had significantly lower species richness and evenness. In addition, bank destabilization and sedimentation resulting from grazing also caused increased levels of chironomidae (Quinn, et al., 1992).

Because terrestrial arthropod diversity is positively related to plant biomass, plant structural diversity and plant species diversity, the changes in the plant community due to cattle grazing in the riparin buffer has a significant influence on the insect community (Rambo and Faeth, 1999; Gibson, et al., 1992). On grazed and ungrazed sections of ponderosa pine-grassland communities in Arizona, no significant effect to insect species evenness and richness occurred (Rambo and Faeth, 1999). However, these grazed areas did influence the abundance of insect communities. What was discovered was that in long-term exclosures, insect abundance was four to ten times higher than in continually grazed areas (Rambo and Faeth, 1999).

Riparian Arthropod Collection Techniques

Vacuum sampling in these habitats is used to collect terrestrial arthropods along the water line around each pond. This technique is performed by using a gas leaf blower with a vacuum tube attached (Smith, 1999). At each habitat of each pond, a piece of panty hose is fitted onto the tube, and a ten (length) by three meter (width) transect is vacuumed in and along the vegetation. Samples are then sorted and identified. Arthropods to be expected in these samples include ground dwelling insects and spiders, foliage-dwelling arthropods, as well as some flying insects. Post-burn sampling within riparian buffers may reflect arthropods that moved into those areas to seek refuge during or after the controlled burn, or arthropods that were there and remained unaffected by the burn. Post-burn sampling in riparian areas that were burned to the waters' edge may reflect re-colonization events of different arthropod groups.

CHAPTER III

METHODOLOGY

Eight ponds within the cross timbers rangeland were evaluated (Fig. 2). The ponds used were all approximately 2000 to 2500 square meters in area. Each pond generally had the same shape and size. The watershed area of these ponds consisted of a mixture of grassland and trees.

Three of the ponds received a treatment of complete watershed burning (complete burn) up to the water's edge (Fig. 2). Each of the other three treatment ponds received the treatment of complete watershed burning with the exception of a 10 meter riparian buffer around the perimeter of the pond (Fig. 2). This buffer was allowed to grow, while the vegetation outside of this area surrounding the pond was burned. All six of the treatment ponds were subject to grazing by cattle at the rate of 17 acres/head. Two ponds were considered reference ponds, one which has been excluded from grazing and has not been subject to a controlled burn for over 20 years (Fig. 2). The other reference pond is subject to grazing at the same rate as the treatment ponds, but has not been subject to controlled burn for two to five years.

Post burn sampling

Burning took place on April 8, 2009. The staff at the OSU Research Rangeland was responsible for the burning of all six ponds, as well as the implementation of the vegetative buffer used on three of the treatment ponds. Each of these ponds was sampled prior to burning to obtain baseline data. Following the burn, each pond was then sampled once a week for a month, and then once a month for three months. Weekly transects were selected based on habitat type, size (large enough for 10 m transect), as well as location along waterline. The four weekly samples were sorted and identified for this study. The monthly samples remain archived in the

Department of Entomology and Plant Pathology at Oklahoma State University in Stillwater, Oklahoma.

Riparian Arthropod Collection

Each sampling event consisted of a ten meter length, three meter width, and one meter height (only when vegetation grew at least that height) transect in each habitat type of the riparian zone. Habitat types include: grass, shrubs, and trees. A D-VAC collection vacuum; a gas-powered leaf blower with a vacuum attachment was used for all sampling events throughout the study (Smith, 1999). The D-VAC used was a TB320BV (Troy-Bilt) with an airflow volume of 425 cubic feet per minute. A piece of pantyhose was fitted over and taped onto the collection vacuum. This gave the D-VAC an approximate mesh size of 50-100 microns. When vacuuming, the collector kept the tube near ground-level, sweeping the ground and subsequently moving up any vegetation encountered. Each sample event occurred at the same time of day (approx. 8 a.m.) and was collected in the same order. Samples were then placed into labeled bags and frozen. Global positioning system (GPS) data was also collected at each collection site at each pond, so as to ensure that the same transect was used for each sample event. Weather data was collected through the use of MESONET for each sample date, including pre and post-burn.

Identification and Analysis

Following collection, samples were frozen prior to sorting. Samples were then sorted and preserved in 80% ethanol. Insects were identified to the taxonomic level of family whenever possible. As a means of quality control, voucher or representative specimens of each taxon were sent off for verification. The data was then analyzed in terms of total abundance, diversity, taxa evenness, and taxa richness. Abundance values were based on total number of organisms found within specific taxa.

Diversity values were calculated by using the Shannon-Wiener Diversity Index (Shannon and Weaver, 1949). This metric is used to measure the prevalence of taxa or species within a community or sample. An advantage to this metric is the ability to examine diversity at both spatial and temporal scales (Bassett, et al., 2008). To calculate this metric, the formula:

$$H' = -\sum_{i=1}^{S}(p_i \ln p_i) - [(S-1)/2N]$$

was used, where S is the total number of taxa, p_i is the relative abundance for each taxon (proportion of individuals in taxa to total number of individuals in a sample), and N is the total number of all individuals.

Taxa evenness was calculated by taking the value obtained in the Shannon-Wiener Diversity Index, and dividing that value by the taxa richness (number of unique taxa) for that sample. This calculation produces numbers ranging from zero to one, and is used to show the distribution of taxa within the community (Stirling and Wilsey, 2001). Values nearer to one demonstrate a population that is more even, while values closer to zero occur when one particular taxon begins to dominate. These changes to the prevalence of taxa within the community also influenced the taxa richness for each sample. Richness values were equivalent to the total number of unique taxa found within a sample. This metric is often used as a means of expressing the homogeneity of an environment, as well as its sensitivity to disturbance (Merritt and Cummins, 1996; Stirling and Wilsey, 2001).

Statistical analysis

These metrics were calculated for each riparian habitat type of each pond and for each of the experimental and reference ponds on each individual sampling date. C SAS Version 9.2 (SAS Institute, Cary, NC) was used for all statistical analyses. Analysis of variance procedures (PROC MIXED) were used to determine the effect combined effects of treatment, habitat and time on the various response variables. A split plot model with repeated measures and an autoregressive (period one) covariance structure was used to model the data. Treatment was the main unit factor, habitat was the split unit factor, and time was the repeated measures factor. The effect of treatment at each habitat type-time point combination was assessed through comparisons of the simple effects with a SLICE option in an LSMEANS statement, and the multiple levels of treatment were compared with pairwise t tests conducted when the simple effects were significant. Means and standard errors of the mean are reported, and a 0.05 level of significance was used for all comparisons.

CHAPTER IV

FINDINGS

Arthropod abundance

Differences in abundance due to both time and treatment were observed. Abundance of all arthropod groups within the riparian zones, increased over time in all six of the treatment ponds. Fluctuations in arthropod abundance were less pronounced in the riparian zones of the reference ponds that were not subject to controlled burn in their watershed (Table 1). Total abundance of riparian insects did not differ significantly between treatment and reference ponds during any of the sample periods throughout the study. Despite this, a general trend developed throughout the study. Following the burn, increases in total abundance of arthropods on post burn week one were observed on all ponds except northeast pasture (grass habitat) and southwest pasture west (grass) (Table 1). Otherwise, abundance values increased on week two post-burn. Mean total abundance in both treatments on grass habitats (watershed burn with a 10m riparian buffer, and watershed burn without a 10m riparian buffer) fell from week three to four, to return to levels near that of pre-burn samples (Table 1).

Following the burn, all of the ponds throughout each of the treatments responded with differing arthropod recolonization rates. Most samples displayed a noticeable difference from pre-burn to post-burn week one, while to samples had either little response or a reduction in abundance values. Although the change from week one post-burn to week two was less obvious, a similar pattern emerged. Despite this, more samples with reductions or little differences were noted.

In contrast to the reference and buffer treatment ponds, arthropods on the no buffer treatment displayed a mix of changes. While arthropods on some ponds and habitats of the no-buffer treatment increased in abundance substantially (Southwest pasture NE grass, Junkyard middle grass and shrubs), others either decreased or remained relatively constant (Northeast pasture, Junkyard middle trees) (Table 1).

Between weeks two and three, arthropod abundance on the majority of all ponds and habitats appeared to plateau. Arthropods on reference pond habitats either decreased in abundance or remained relatively constant from week two to three. Changes in arthropod abundance on ponds without a riparian buffer were variable. On one pond (Northeast pasture), a decrease in arthropod abundance occurred on both habitats, while abundance increased in grass and shrub habitats in the Junkyard middle pond (Table 1). With the exception of the southwest pasture east pond (grass and shrubs), abundance on all ponds and habitats either decreased or remained relatively constant. In week four post-burn, a decrease in arthropod abundance is observed in all treatments except the northeast pasture pond; grass sample, and two reference pond samples (Table 1).

Diversity

The Shannon Wiener diversity index displayed no significant changes in any treatments due to controlled burning. Diversity generally increased from pre-burn to post burn week one and two, but remained relatively constant after week two (Table 2). By week two post-burn, both the reference ponds and buffer treatment ponds displayed a mean diversity index value that was higher than the no buffer treatment ponds. After week two post-burn, the reference and no buffer treatment ponds diversity values remained similar, while the buffer treatment ponds displayed a higher mean diversity value in weeks three and four (Table 2).

Evenness values indicated an even population in pre-burn samples, with all three treatments means ranging from 0.714 to 0.783 (Table 3). Following the burn, a decrease in evenness was observed on all treatments from pre-burn to post-burn week one. Weeks two and three remained relatively constant, with the reference pond mean evenness value above that of both treatment ponds. On week four, mean evenness for both treatment ponds increased from 0.344 to 0.563 (no buffer), and 0.379 to 0.519 (buffer), while the reference pond mean evenness decreased from 0.427 to 0.389 (Table 3). Initially, this metric indicated that following a disturbance, mean evenness values of arthropods on treatment ponds were generally lower than that of the reference pond. In contrast, by week four post-burn both treatments had higher mean evenness values than the reference ponds.

Pre-burn taxa richness means values were similar on the reference ponds, and both treatments. An increase in taxa richness occurred from pre-burn samples to post burn week one and two (Table 4). Following this, reference pond richness decreased from week two to three, but remained similar for week four (Table 4). In contrast, richness in both treatments decreased from week two to three, and again from week's three to four post-burn (Table 4). Differences in riparian insect taxa richness were apparent in both tree and shrub habitats within the ponds that contained riparian buffers. Taxa richness was significantly lower in the shrub habitat of the reference pond relative to shrub habitat in either treatment (ten meter buffer and no buffer) (Table 4). Mean taxa richness in tree habitats (week 1) was significantly lower in the ten meter buffer pond treatment, while the reference and no buffer pond treatments showed statistically similar richness values (Table 4).

Community composition

Within riparian shrub habitats, Brachycerous flies exhibited a positive response to controlled burning. Brachycera were found in higher numbers in both treatment ponds relative to the reference ponds for weeks two and three. In contrast, Brachycera on tree habitats displayed a significant difference in total abundance between ponds with and without a vegetative buffer (Fig. 3). While significant differences were found between buffer and no buffer treatments, the reference ponds were found to be statistically similar in total Brachycera abundance to both buffer and no buffer treatments (Fig. 3).

The paraphyletic grouping of Nematocerous flies was significantly more abundant when riparian vegetation was present (in the reference ponds and ten meter riparian buffer treatment) (Fig. 4). The analysis of Diptera showed less significance than when analyzed individually by suborder (Brachycera and Nematocera). For week two in the grass habitat, the ten meter buffer showed a significantly higher mean total Dipteran abundance when compared to no buffer ponds, while the reference ponds were found to be similar to both treatments (Fig. 5).

Araneae was another order which exhibited a response to controlled burning. In grass habitats, spiders did not recover quickly following this disturbance. Specifically, spiders on reference ponds were found to be significantly more abundant on post burn week three than either of the burned ponds (Fig. 6). The same trend was visible in the other three weeks of the study, but the difference was not significant.

Despite being one of the most abundant taxa observed throughout the study, Formicidae showed no significant changes related to burning or the presence of a vegetative buffer. Parasitic Hymenoptera also displayed no significant differences, but still exhibited some differences between differing habitat types. In the grass habitat, no buffer treatment ponds were found to have fewer parasitic wasps than both reference and ten meter buffer treatment ponds. In contrast, parasitic wasps in shrubs habitats were less abundant in the reference ponds than in the treatment ponds.

Aphididae did not differ in abundance due to treatment, but one main trend was observed. In the pre-burn samples for all three habitats, aphid abundance was essentially zero. Following the burn event, aphid abundance in grass was similar throughout the reference, buffer, and no buffer treatments, while shrubs and trees habitats in the ten meter buffer treatment contained more aphids than the no buffer treatment and reference ponds.

One of the most abundant taxa, Auchenorrhyncha, exhibited trends that were much more erratic. Auchenorrhyncha in grass habitats were found to be significantly more abundant on reference ponds on week two post burn than the other treatments (Fig. 7). On week two, the ten meter buffer pond treatment was found to be similar to the reference ponds, but still significantly more abundant than in the no buffer pond treatment (Fig. 7). In addition, this general trend of higher mean abundance for Auchenorrhyncha in the reference pond treatment was also observed during the other samples dates, but no significant differences were seen.

Coleoptera exhibited the most significant changes over time. In both tree and shrub habitats, significantly higher abundance on the reference ponds (week four) were seen when compared to that of the two treatments (Fig. 8). In addition, beetles found in grass habitats demonstrated two conflicting but significant trends. On week two post burn, the reference ponds had a mean abundance of 31.5 while the two treatments had values of 10 and 11 (Fig. 8). Mean Coleoptera on the no buffer ponds were the most abundant (16) on week three post burn, while Coleoptera on reference ponds were significantly less abundant (6.5) (Fig. 8). The ten meter buffer ponds were found to be similar to both reference and no buffer ponds (10.67) (Fig. 8). Significant difference seen in shrub habitat (week two) for Thysanoptera has been disregarded due to an outlier sample skewing the data.

CHAPTER V

CONCLUSIONS

Arthropod abundance

This study's findings suggest that following a disturbance such as controlled riparian burning, significant changes were observed at the levels of abundance, diversity and community composition. Despite this, no observable differences between abundance means in different habitat types occurred. Significant differences that occurred within each of these metrics were taxa specific. Overall, two main themes or results occurred throughout the study. First of all, following the burn, an initial sharp increase in taxa abundance, richness and Shannon-Wiener diversity were observed. Quick responses generally occurred through week two, with a leveling out occurring on weeks three and four. Evenness values generally dropped following the burn and recovered by the fourth week post-burn, with the exception of the reference ponds, which did not recover by the end of the study. Changes in evenness are difficult to group with the other metrics, as evenness values are a ratio. Specific taxa follow this pattern of quick responses and an eventual recovery by the end of the fourth week post-burn. Examples of this would be Diptera, Coleoptera, and Auchenorrhyncha.

Overall, another theme applied throughout the study. Differences observed in the community composition of arthropods following a burn were often taxa and habitat dependent. Although abundance responded quickly following the burn, taxa such as Araneae did not increase in abundance following a burn.

Significant differences between Araneae on treatment ponds were seen on week three post-burn, with similar but non-significant differences also observed on week four post-burn. Differences between habitat types were mostly observational. On tree habitats in all treatments, Diptera and Hymenoptera were found to be more abundant than on grass and shrub habitats. Arthropods on grass habitats consisted of a variety of herbivorous Hemiptera, such as Auchenorrhyncha and Lygaeidae, as well as spiders preying on these herbivorous insects. Within the shrub habitat in all treatments, often the highest abundance was observed.

Coleoptera and Araneae were found to be generally more abundant on reference sites than the no buffer or 10m vegetative buffer treatments. On unburned (reference) sites, a well-established arthropod community exists. Because of their mobility or dwelling in burrows, many spiders survive fires. Due to a lack of prey options during the shock phase following disturbances, spiders may vacate the area (Nagel, 1973; Warren, et al., 1987). Remaining spiders on burned areas may be affected long term, with spring burns on Kansas grasslands causing a significant decrease in mean Araneae weight on burned plots as compared to unburned (0.114 and 0.131 g) (Nagel, 1973).

Beetles display a similar pattern following a burn. Coleoptera were significantly more abundant in tree and shrub habitats of reference ponds. This difference occurred on week two post burn, and by week three, beetles within the no buffer pond treatment were significantly more abundant compared to the reference ponds. This suggests that beetles are likely leaving the area during a disturbance and not returning following, likely due to lack of food sources (Warren, et al., 1987). A lack of response would be expected throughout the feeding guilds within Coleoptera.

Flies were found to be most abundant on 10 m buffer treatment ponds, but were statistically similar in abundance to that of flies on reference ponds. On no buffer treatment ponds displayed, Diptera displayed a lower prevalence than on 10 m buffer treatments and references. For predatory flies, this response may be attributed to a lack of available prey following a burn (Warren, et al., 1987). Non-predatory Diptera, such as some adult Tipulidae rely on cultivated plants for food and reproduction (Borror, et al., 1987). Other Diptera families, like Syrphidae, are pollinators of terrestrial plants, thus they rely on the nectar as a food source (Ssymank, et al., 2008). Changes to the vegetative ecosystem may cause herbivorous and pollinating flies to search for other opportunities.

Herbivorous arthropods, such as Auchenorrhyncha were generally more abundant on reference and 10m buffer ponds, as compared to no buffer ponds. On the no buffer treatment ponds, an initial reduction in available production energy occurs. The vegetative buffer treatment would see less of a reduction in production energy, and this may influence Auchenorrhyncha abundance (Nagel, 1973).

Diversity

Taxa richness and diversity generally increased in the first and second week post-burn, and then leveled out in the third and fourth week post-burn. Corresponding evenness values decreased in the first and second weeks post-burn, and recovered in the third and fourth weeks. This may be attributed to returning or immigrating arthropods into the area. Increases in the abundance of certain taxa (Auchenorrhyncha) coupled with the decreases observed to others (Araneae) may explain this shift in taxa evenness. The return of predatory taxa following disturbance would itself cause a shift in taxa evenness. Coupled with the predation that would also occur may explain a shift from low evenness (few dominant species) to higher evenness (more uniform distribution, no dominant species).

As a whole, no significant changes were observed in overall abundance, taxa evenness, and diversity indices due to treatment. Influences by range management practices may have been detected within these metrics had there been finer taxonomic resolution. Within an order, different functional feeding groups and life strategies exist. Had the samples been identified to a lower taxonomic level, a more accurate representation to the evenness or diversity within an order would likely be seen.

Despite this, several trends were observed in all of the ponds (both reference and treatment) following the burn. Changes in taxa richness were found to occur in both tree and shrub habitats. Tree habitat richness values suggest that the ten meter buffer treatment either was slower to recover, or that one taxon tended to dominate immediately following a burn. While the shrubs habitat in general was analyzed cautiously due to low sample sizes, a significantly lower taxa richness value was observed on reference ponds within shrub habitats. This difference may be attributed to changes in weather conditions or sample variation.

Taxa evenness, which indicates the distribution of abundance across taxa richness, showed a similar response throughout the reference and treatment ponds. Following the burn, mean taxa evenness decreased throughout the reference ponds and the treatment ponds. The low values observed may indicate that one or a few taxa within the ecosystem are faster recolonizers following a disturbance, and may be due to phytophagous insects such as Hemipterans (Reed, 1997; Dunwiddie, 1991). Basically, as new plants sprout in the recently burned rangeland, certain organisms may return significantly quicker, and in higher numbers, while others may not return at all. This may help explain the differences observed in taxa richness. Had the experiment continued, with samples taken for months after the experiment, a full recovery may have been observed.

Community composition

Brachycera were observed to have a significantly higher density in grass of the ten meter buffer treatment when compared to the no buffer treatment. Similar results were also observed with Nematocera in grass and shrubs habitats. Differences observed may be due to a lack of suitable vegetation to serve as a refuge. Prey availability, especially for Brachycera, may be another explanation for the observed density differences (Warren, et al., 1987). A lack of prey options for Brachycera, many of which are predatory (i.e. Tabanidae, Asilidae, Rhagionidae) would be detrimental to the Dipteran community. Initially after the burn, the 10 m buffer treatment ponds would still be available for grazing by cattle, whereas the no buffer treatment ponds would require time for plants to resprout before grazing could occur. The difference between 10 m buffer and no buffer treatments may also be related to slow recoveries of other predaceous arthropods, such as spiders.

Spiders were a group that did not recover quickly. Despite their high mobility, Araneae were more abundant on reference ponds than on treatment ponds. This may be due to a lack of prey found around these ponds following a burn (Reed, 1997; Dunwiddie, 1991). Another explanation may be related to plant succession. A change in the makeup of the plant community following a disturbance has been found to influence spider species and population density (Hatley, and MacMahon, 1980). Spider dispersal may be another explanation for a slow recovery. In response to disturbance, some spiders have been found to either balloon (using silk to catch wind currents) or walk to safety. This method of dispersal was species dependent, and varied greatly in range: a few meters to many kilometers (Langlands, et al., 2011).

Several of the most abundant taxa within the study showed little to no significant responses. Both Formicidae and Aphididae were both primarily found in grass habitats, and showed a consistent response throughout each treatment. Following the burn, both taxa were found to respond quickly, with abundance peaking by week 2. By week 4, abundance values had reduced to near pre-burn levels. The response of Formicidae was similar to that of several studies (McCullough, et al., 1998; Nagel, 1973; Reed, 1997; Warren, et al., 1987). This quick response may be due to a tolerance for dry soil and their social habits are beneficial for fast recolonization

(Warren, et al., 1987). Quick recolonization by Aphididae was likely due to vegetation resprouting (Nagel, 1973; Reed, 1997).

Following a burn, another prevalent group, Auchenorrhyncha, displayed a significant reduction in abundance on treatment ponds as compared to reference ponds. This significant reduction only occurred on grassy habitats of the study, as this is the habitat type these insects primarily inhabit. During weeks two and four post burn, Auchenorrhyncha were significantly more abundant on reference ponds than on the 10m buffer or no buffer treatments. Although this was the only significant difference noted, throughout the study the reference ponds had a higher overall abundance than both treatments. Reductions in herbivorous arthropods following fire may be due to decreased available production energy (Nagel, 1973).

Conclusions

The riparian interface is a unique environment that combines aquatic and terrestrial systems to create a dynamic ecosystem. Each system shows a dependence upon the other for resources and stability (Baxter, et al. 2005, Paetzold, et al. 2005). Because of this interrelatedness, disturbance to one or both systems can influence the productivity or health of the riparian ecosystem, through changes in abundance, taxa richness and evenness and community composition.

Following any disturbance, arthropods respond with differing rates of recolonization. Recolonization rates for a given taxa depend on the ability of a taxa to reach the area, and its ability to re-establish in the ecosystem (Reed, 1997). These two factors are influenced by a number of other elements including prey availability, taxa mobility, newly sprouted plant growth, and population size (Reed, 1997). Another influence on these factors are the differences seen within the disturbance (burning and grazing) itself.

As noted by McCullough (1998), the timing of a burn is important. This is due to the sensitivity and emergence timing of arthropods at different life stages within their lifecycle (McCullough, et al., 1998; Resh, et al., 1988). The timing of the burn may miss many arthropods due to diapause or hibernation (Cancelado and Yonke, 1970). Despite this, spring burns do seem to have an effect on arthropods in diapause. Diapausing arthropods such as spiders have been found to emerge sooner on burned sites, and may leave the area in search of food or structural support for webs (Nagel, 1973).

The application of prescribed burns to any ecosystem is influenced by changes in environmental variables. Wind speed, direction, humidity, air temperature, heat intensity, and spread rate all influence the application of prescribed burns (McCullough, et al., 1998; Bowman and Boggs, 2006). These factors also influence the overall uniformity of a burn, with variations in fire temperature and speed producing differences within a burn site (Warren, et al., 1987). Possible differences within a burn may lead to slight variances in arthropod response due to prescribed fire. Other natural differences do occur besides those associated with burning.

Following the disturbance, spiders and beetles were both observed to recover slowly. These changes correspond to the quick recovery observed with emergent flies like Nematocera and Brachycera. Spiders have been found to exert a top-down effect on ecosystems that they inhabit. Their prevalence reduces the amount of plant damage or blood-feeding by pest insects (Maloney, et al., 2003; Takagi, et al., 1996). Without the predation pressure of spiders, pest taxa are less inhibited (Maloney, et al., 2003). Ultimately, the lack of predation pressure, coupled with the quick recovery of biting flies may also lead to problems with weight gain for cattle and increased plant damage. Although spiders did not recover quickly, it cannot be determined whether range management has a long-term effect on their population.

The observed responses of arthropods may also be attributed to natural seasonal differences. Environmental factors such as photoperiod or temperature influence the time of emergence for arthropods (Nagel, 1973). Steady arthropod emergence and abundance values do not occur throughout the year; variations were observed based on the time of year and type of sampling performed (Boyer, et al., 2003; Lowman, 1982). Specific metrics were also found to differ based on the time of year. On shrub land in Utah, evenness values were rather constant, while species diversity and density peaked in late July and quickly declined by October (Hatley and MacMahon, 1980).

Study limitations

Several limitations arose following the design and implementation of this study, including the influence of natural seasonal changes, and, pre-existing biotic and abiotic differences between the ponds. First of all, while the figures in this study display trends or changes following disturbance, natural seasonal changes may be responsible for some differences seen within the study.

For example, spiders in Utah shrubs were found to demonstrate natural seasonal differences. Evenness values remained constant, but species density and diversity were both found to peak by late July to then quickly decline by October (Hatley and MacMahon, 1980). Other taxa demonstrate a similar trend. On grasslands in central Arkansas, herbivore abundance peaked in August, before declining sharply in September (Boyer, et al., 2003). Carnivore abundance in the same environment was inversely related to seasonal changes to herbivore abundance.

Pond size, shape, location, as well as physical water chemistry may have influenced the data. In order to account for natural variation between the ponds a longer sampling regime with more repetition would be required. Resolution in identification of arthropods was probably the most limiting. This study provides a preliminary overview of recolonization trends of several different arthropod groups following controlled burning with and without the presence of a riparian vegetative buffer.

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TABLES

Table 1: Arthropod abundance in the riparian zone of freshwater ponds with the presence (n=3) or absence (n=3) of 10m riparian buffer (riparian vegetation type: grass, trees or shrubs) in controlled burn of watershed surrounding ponds prior to controlled burn (pre-burn) on 3/18/09 and weekly (post-burn) for 4 weeks

Treatment	**Pond**	**Habitat type**	**Sample Week**				
			Pre-burn	**Post-burn Week 1**	**Post-burn Week 2**	**Post-burn Week 3**	**Post-burn Week 4**
Reference	ENTO	Grass	22	127	339	255	356
Reference	ENTO	Trees	33	84	135	161	89
Reference	Section 4 W	Grass	68	320	514	314	241
Reference	Section 4 W	Shrubs	35	96	162	21	100
No Buffer	SW Pasture NE	Grass	18	375	1821	711	49
No Buffer	SW Pasture NE	Trees	18	311	179	228	50
No Buffer	NE Pasture	Grass	72	14	84	339	41
No Buffer	NE Pasture	Trees	16	85	92	114	227
No Buffer	Junkyard Middle	Grass	21	219	399	208	36
No Buffer	Junkyard Middle	Trees	20	270	99	66	45
No Buffer	Junkyard Middle	Shrubs	30	161	417	366	65
10m Buffer	SW Pasture W	Grass	84	69	505	282	100
10m Buffer	SW Pasture W	Trees	8	13	221	150	73
10m Buffer	SW Pasture W	Shrubs	39	84	312	318	129
10m Buffer	SW Pasture E	Grass	21	348	535	679	62
10m Buffer	SW Pasture E	Trees	9	42	79	163	21
10m Buffer	SW Pasture E	Shrubs	10	310	743	211	98
10m Buffer	Wheatgrass	Grass	9	312	385	67	67
10m Buffer	Wheatgrass	Trees	19	163	390	300	109
10m Buffer	Wheatgrass	Shrubs	21	291	403	277	91

Table 2: Shannon Wiener diversity index (measure of the relationship between taxa richness and evenness within a community) of riparian arthropods of freshwater ponds with the presence (n=3) or absence (n=3) of 10m riparian buffer (riparian vegetation type: grass, trees or shrubs) in controlled burn of watershed surrounding ponds prior to controlled burn (pre-burn) on 3/18/09 and weekly (post-burn) for 4 weeks (values near 1.5 indicate low taxa richness and evenness while values near 3.5 indicated high taxa richness and evenness)

			Sample Week				
Treatment	**Pond**	**Habitat type**	**Pre-burn**	**Post-burn Week 1**	**Post-burn Week 2**	**Post-burn Week 3**	**Post-burn Week 4**
Reference	ENTO	Grass	2.390	2.423	2.380	2.091	1.153
Reference	ENTO	Trees	2.493	2.586	2.577	2.258	2.593
Reference	Section 4 W	Grass	2.629	2.438	2.785	2.603	2.289
Reference	Section 4 W	Shrubs	1.711	2.893	2.961	1.723	2.871
No Buffer	SW Pasture NE	Grass	2.062	2.068	1.031	1.071	2.396
No Buffer	SW Pasture NE	Trees	1.692	2.910	2.426	2.430	1.827
No Buffer	NE Pasture	Grass	2.377	1.352	2.690	2.100	2.019
No Buffer	NE Pasture	Trees	2.288	2.832	2.546	2.468	2.474
No Buffer	Junkyard Middle	Grass	1.951	2.000	1.722	1.504	2.211
No Buffer	Junkyard Middle	Trees	2.290	2.538	2.923	2.641	2.631
No Buffer	Junkyard Middle	Shrubs	2.128	2.673	2.337	2.156	2.317
10m Buffer	SW Pasture W	Grass	1.830	1.959	1.818	1.754	1.892
10m Buffer	SW Pasture W	Trees	1.906	1.992	2.610	1.937	2.905
10m Buffer	SW Pasture W	Shrubs	2.384	2.608	2.075	1.845	1.991
10m Buffer	SW Pasture E	Grass	2.351	2.602	2.923	2.146	2.537
10m Buffer	SW Pasture E	Trees	1.581	1.772	2.568	2.859	1.946
10m Buffer	SW Pasture E	Shrubs	1.643	3.011	1.835	2.721	1.966
10m Buffer	Wheatgrass	Grass	1.972	2.186	2.333	2.743	1.979
10m Buffer	Wheatgrass	Trees	1.689	2.420	3.073	2.711	3.085
10m Buffer	Wheatgrass	Shrubs	1.988	2.449	2.839	2.879	3.001

Table 3: Taxa evenness (low values indicate uneven taxa distribution within a community, high values indicate numerically even community) for riparian arthropods of freshwater ponds with the presence (n=3) or absence (n=3) of 10m riparian buffer (riparian vegetation type: grass, trees or shrubs) in controlled burn of watershed surrounding ponds prior to controlled burn (pre-burn) on 3/18/09 and weekly (post-burn) for 4 weeks

Treatment	Pond	Habitat type	Sample Week				
			Pre-burn	Post-burn Week 1	Post-burn Week 2	Post-burn Week 3	Post-burn Week 4
Reference	ENTO	Grass	0.779	0.434	0.300	0.219	0.167
Reference	ENTO	Trees	0.864	0.531	0.454	0.354	0.514
Reference	Section 4 W	Grass	0.660	0.382	0.450	0.436	0.340
Reference	Section 4 W	Shrubs	0.554	0.582	0.585	0.700	0.535
No Buffer	SW Pasture NE	Grass	0.786	0.304	0.088	0.133	0.686
No Buffer	SW Pasture NE	Trees	0.776	0.437	0.353	0.392	0.478
No Buffer	NE Pasture	Grass	0.673	0.644	0.566	0.272	0.502
No Buffer	NE Pasture	Trees	0.758	0.679	0.672	0.492	0.339
No Buffer	Junkyard Middle	Grass	0.880	0.296	0.165	0.214	0.761
No Buffer	Junkyard Middle	Trees	0.823	0.383	0.620	0.638	0.694
No Buffer	Junkyard Middle	Shrubs	0.763	0.536	0.259	0.270	0.483
10m Buffer	SW Pasture W	Grass	0.416	0.417	0.228	0.206	0.349
10m Buffer	SW Pasture W	Trees	0.961	0.916	0.486	0.302	0.630
10m Buffer	SW Pasture W	Shrubs	0.723	0.679	0.265	0.264	0.305
10m Buffer	SW Pasture E	Grass	0.874	0.450	0.477	0.244	0.632
10m Buffer	SW Pasture E	Trees	0.810	0.654	0.483	0.459	0.636
10m Buffer	SW Pasture E	Shrubs	0.862	0.483	0.153	0.434	0.286
10m Buffer	Wheatgrass	Grass	0.898	0.318	0.344	0.675	0.517
10m Buffer	Wheatgrass	Trees	0.774	0.450	0.514	0.407	0.683
10m Buffer	Wheatgrass	Shrubs	0.730	0.445	0.407	0.424	0.628

Table 4: Taxa richness (number of unique taxa) of riparian arthropods of freshwater ponds with the presence (n=3) or absence (n=3) of 10m riparian buffer (riparian vegetation type: grass, trees or shrubs) in controlled burn of watershed surrounding ponds prior to controlled burn (pre-burn) on 3/18/09 and weekly (post-burn) for 4 weeks

			Sample Week				
Treatment	**Pond**	**Habitat type**	**Pre-burn**	**Post-burn Week 1**	**Post-burn Week 2**	**Post-burn Week 3**	**Post-burn Week 4**
Reference	ENTO	Grass	14	26	36	37	19
Reference	ENTO	Trees	14	25	29	27	26
Reference	Section 4 W	Grass	21	30	36	31	29
Reference	Section 4 W	Shrubs	10	31	33	8	33
No Buffer	SW Pasture NE	Grass	10	26	32	22	16
No Buffer	SW Pasture NE	Trees	7	42	32	29	13
No Buffer	NE Pasture	Grass	16	6	26	30	15
No Buffer	NE Pasture	Trees	13	25	19	24	35
No Buffer	Junkyard Middle	Grass	8	25	34	21	12
No Buffer	Junkyard Middle	Trees	12	33	30	22	20
No Buffer	Junkyard Middle	Shrubs	11	27	40	32	21
10m Buffer	SW Pasture W	Grass	15	17	27	28	19
10m Buffer	SW Pasture W	Trees	7	8	28	23	29
10m Buffer	SW Pasture W	Shrubs	15	20	30	24	24
10m Buffer	SW Pasture E	Grass	12	30	39	35	20
10m Buffer	SW Pasture E	Trees	6	9	27	38	11
10m Buffer	SW Pasture E	Shrubs	6	42	41	35	25
10m Buffer	Wheatgrass	Grass	8	28	30	23	14
10m Buffer	Wheatgrass	Trees	7	25	42	37	32
10m Buffer	Wheatgrass	Shrubs	10	26	42	42	32

Table 5: **Mean abundance ± s.e.** of Arthropod taxa exhibiting significant effects ($p<0.05$) to presence (n=3) or absence (n=3) of 10m riparian buffer (riparian vegetation type: grass, trees or shrubs) in controlled burn of watershed surrounding ponds prior to controlled burn (pre-burn) on 3/18/09 and weekly (post-burn) for 4 weeks

	Treatment	Diptera	Nematocera	Brachycera	Araneae	Auchenorrhyncha	Coleoptera
Pre-burn Mean (± s.e.)	10m buf.	21.67 (20.17)	20.33 (19.84)	1.33 (0.67)	3.67 (2.03)	2.67 (0.33)	1.33 (0.33)
	No buf.	6.33 (1.86)	3.67 (0.33)	2.67 (1.76)	10.33 (2.60)	5.67 (3.67)	0.67 (0.67)
	Ref.	14.00 (12.00)	10.50 (10.50)	3.50 (1.50)	8.50 (1.50)	8.50 (2.50)	1.50 (0.50)
PB Wk 1 Mean (± s.e.)	10m buf.	111.00 (50.72)	**95.33 (47.34)**	14.67 (5.24)	3.00 (2.52)	14.33 (7.84)	7.33 (1.86)
	No buf.	40.33 (25.67)	**26.67 (17.27)**	13.67 (8.41)	1.67 (0.88)	12.33 (6.49)	6.67 (3.38)
	Ref.	36.00 (21.00)	**17.00 (10.00)**	19.00 (11.00)	6.50 (0.50)	28.00 (6.00)	14.50 (4.50)
PB Wk 2 Mean (± s.e.)	10m buf.	**104.33 (45.73)**	55.33 (26.44)	**49.00 (19.31)**	5.67 (1.20)	**53.00 (8.19)**	**10.00 (2.52)**
	No buf.	**14.00 (2.31)**	8.00 (0.58)	**6.00 (1.73)**	6.67 (0.33)	**23.33 (12.25)**	**11.00 (4.16)**
	Ref.	**68.00 (37.00)**	37.50 (28.50)	**30.50 (8.50)**	10.50 (6.50)	**63.50 (0.50)**	**31.50 (4.50)**
PB Wk 3 Mean (± s.e.)	10m buf.	32.67 (16.71)	10.00 (1.53)	22.67 (15.67)	**4.33 (2.33)**	37.67 (18.55)	**10.67 (3.48)**
	No buf.	32.00 (18.18)	14.67 (12.68)	17.33 (7.31)	**2.67 (1.33)**	37.00 (11.27)	**16.00 (2.08)**
	Ref.	44.00 (22.00)	25.00 (18.00)	19.00 (4.00)	**15.00 (1.00)**	65.00 (19.00)	**6.50 (3.50)**
PB Wk 4 Mean (± s.e.)	10m buf.	3.33 (2.85)	2.67 (2.19)	0.67 (0.67)	1.33 (0.67)	**19.00 (5.77)**	8.00 (4.93)
	No buf.	3.67 (0.67)	1.33 (0.88)	2.33 (1.20)	1.67 (1.20)	**8.00 (2.89)**	6.33 (2.40)
	Ref.	17.50 (11.50)	9.50 (8.50)	8.00 (3.00)	7.50 (1.50)	**56.00 (5.00)**	5.50 (1.50)

FIGURES

Figure 1: Aerial map of Oklahoma State University Research Rangeland

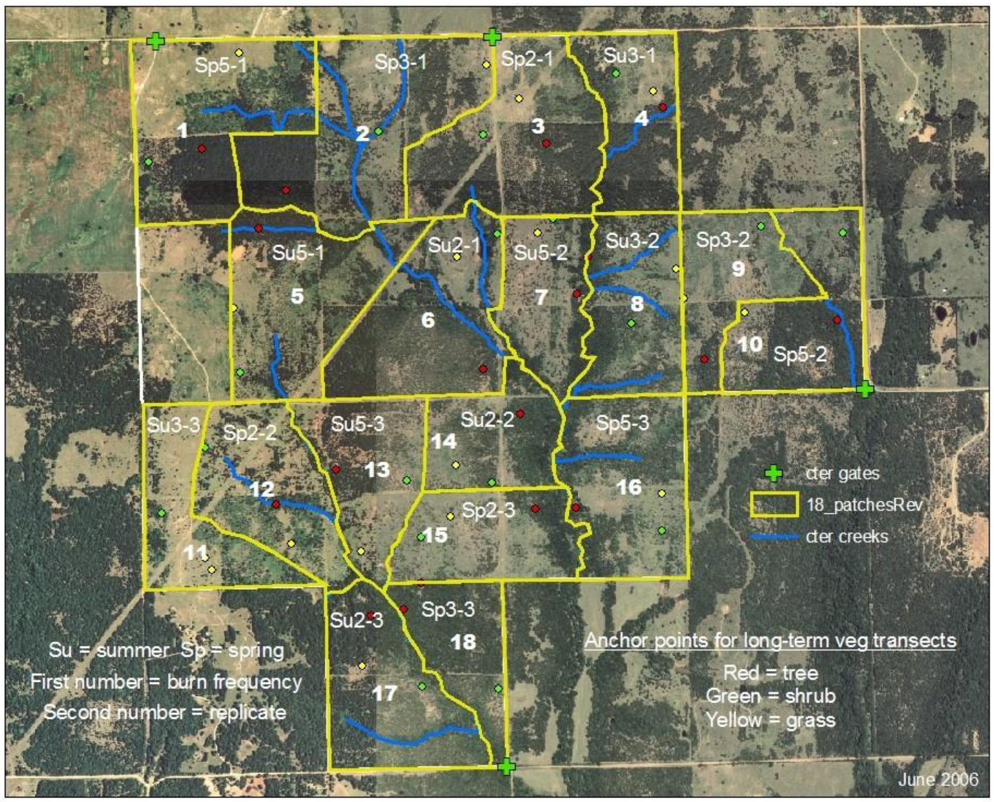


Figure 2: Sampling schematic of cross timbers rangeland ponds with presence (n=3) or absence (n=3) of 10m riparian buffer (riparian vegetation type: grass, trees or shrubs) prior to controlled burn (pre-burn) on 3/18/09 and weekly (post-burn) for 4 weeks

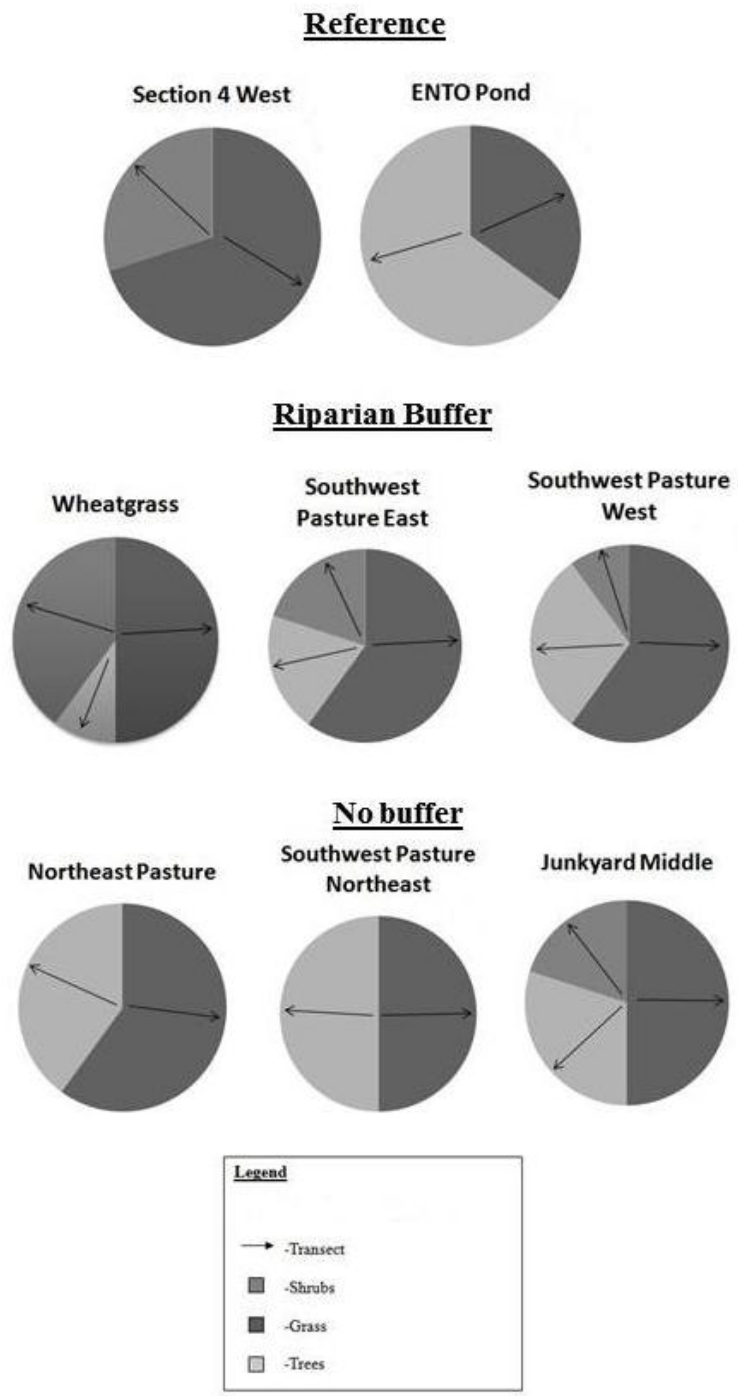


Figure 3: **Mean ± s.e.** of *Brachycera* exhibiting significant effects (ANOVA) ($p<.05$) to presence (n=3) or absence (n=3) of 10M riparian buffer (riparian vegetation type: grass, trees or shrubs) in controlled burn of watershed surrounding ponds prior to controlled burn (pre-burn) on 3/18/09 and weekly (post-burn) for 4 weeks. A, B, and AB are implemented on samples dates where significance occurred, and display significant differences or similarities between treatments.

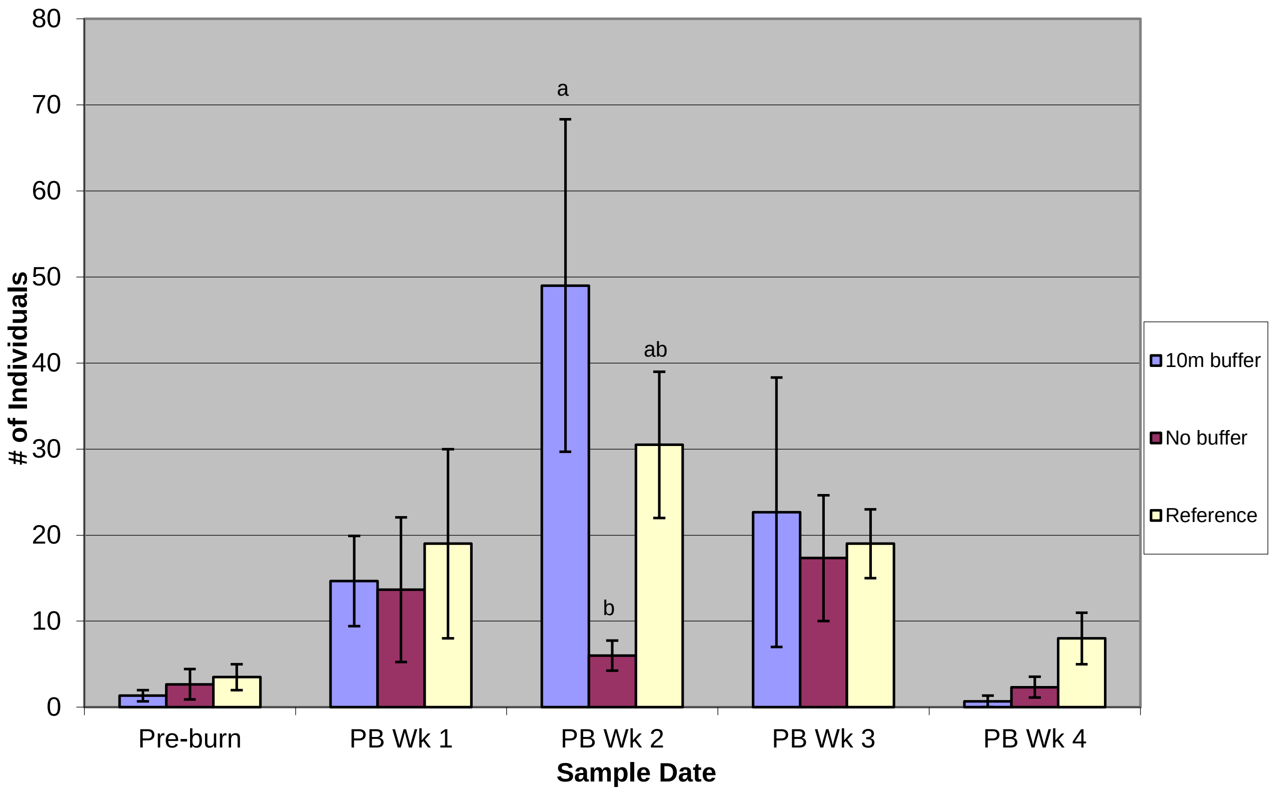


Figure 4: **Mean ± s.e.** of *Nematocera* exhibiting significant effects (ANOVA) ($p<.05$) to presence (n=3) or absence (n=3) of 10M riparian buffer (riparian vegetation type: grass, trees or shrubs) in controlled burn of watershed surrounding ponds prior to controlled burn (pre-burn) on 3/18/09 and weekly (post-burn) for 4 weeks. A, B, and AB are implemented on samples dates where significance occurred, and display significant differences or similarities between treatments.

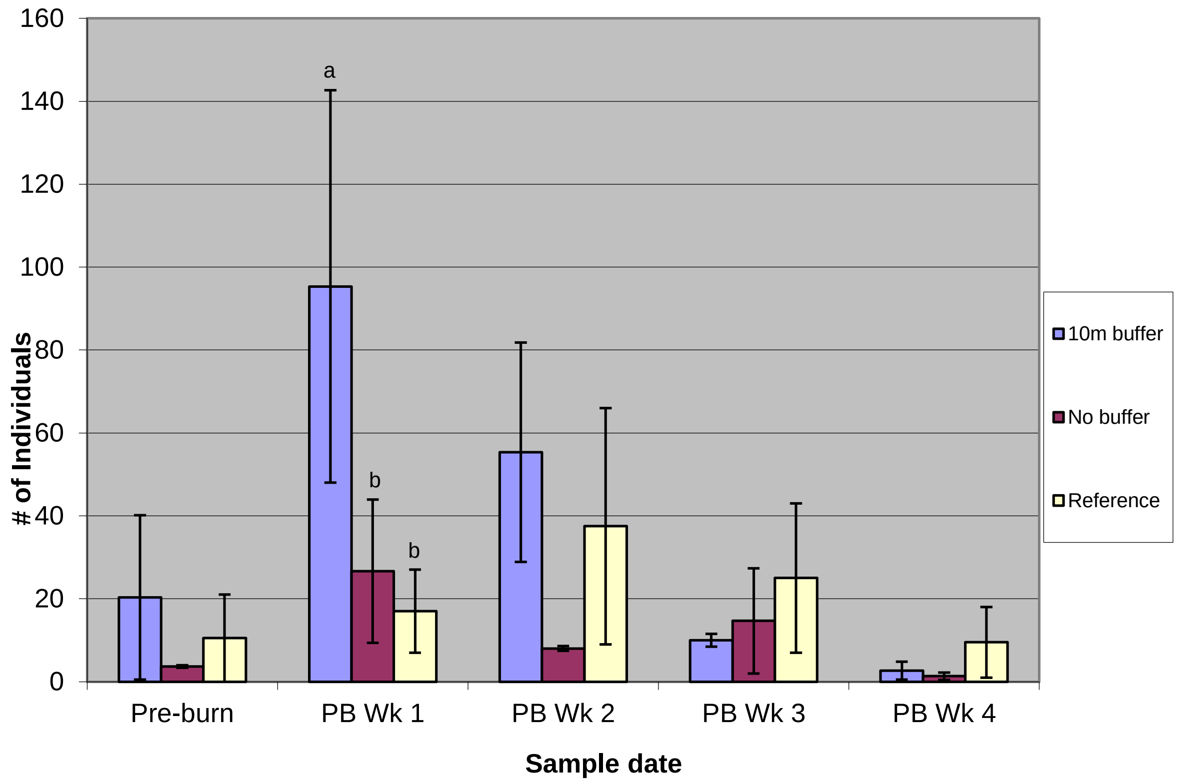


Figure 5: **Mean ± s.e.** of *Diptera* exhibiting significant effects (ANOVA) (p<.05) to presence (n=3) or absence (n=3) of 10M riparian buffer (riparian vegetation type: grass, trees or shrubs) in controlled burn of watershed surrounding ponds prior to controlled burn (pre-burn) on 3/18/09 and weekly (post-burn) for 4 weeks. A, B, and AB are implemented on samples dates where significance occurred, and display significant differences or similarities between treatments.

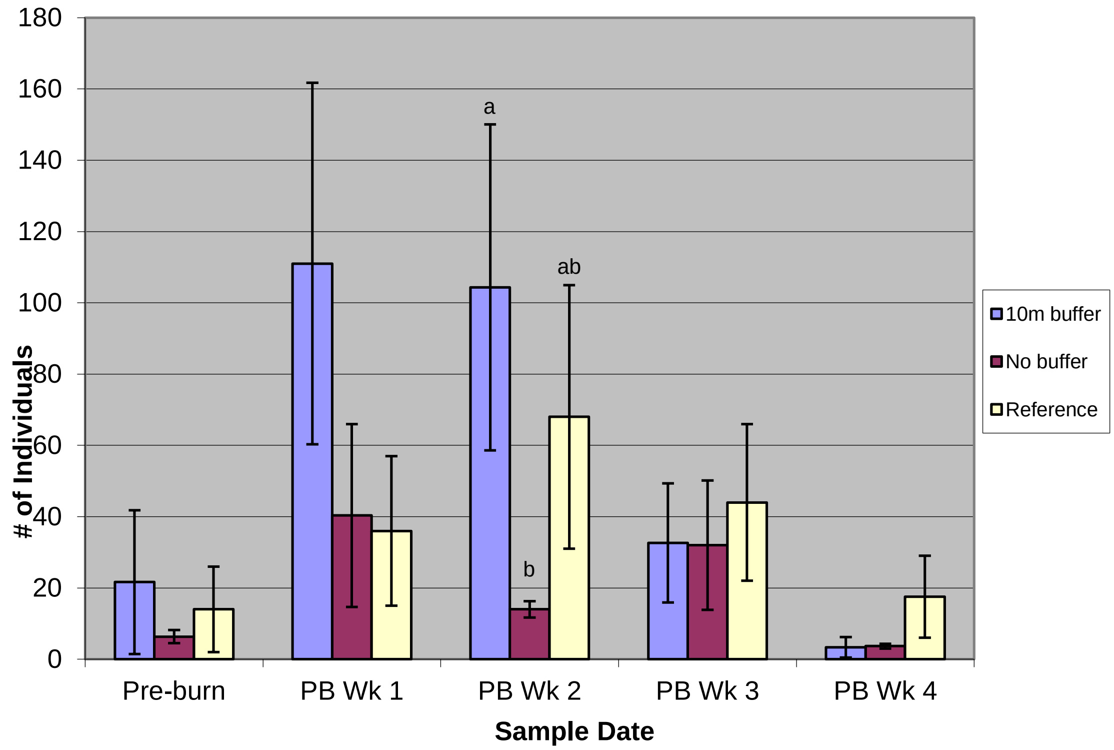


Figure 6: **Mean ± s.e.** of *Araneae* exhibiting significant effects (ANOVA) ($p<.05$) to presence (n=3) or absence (n=3) of 10M riparian buffer (riparian vegetation type: grass, trees or shrubs) in controlled burn of watershed surrounding ponds prior to controlled burn (pre-burn) on 3/18/09 and weekly (post-burn) for 4 weeks. A, B, and AB are implemented on samples dates where significance occurred, and display significant differences or similarities between treatments.

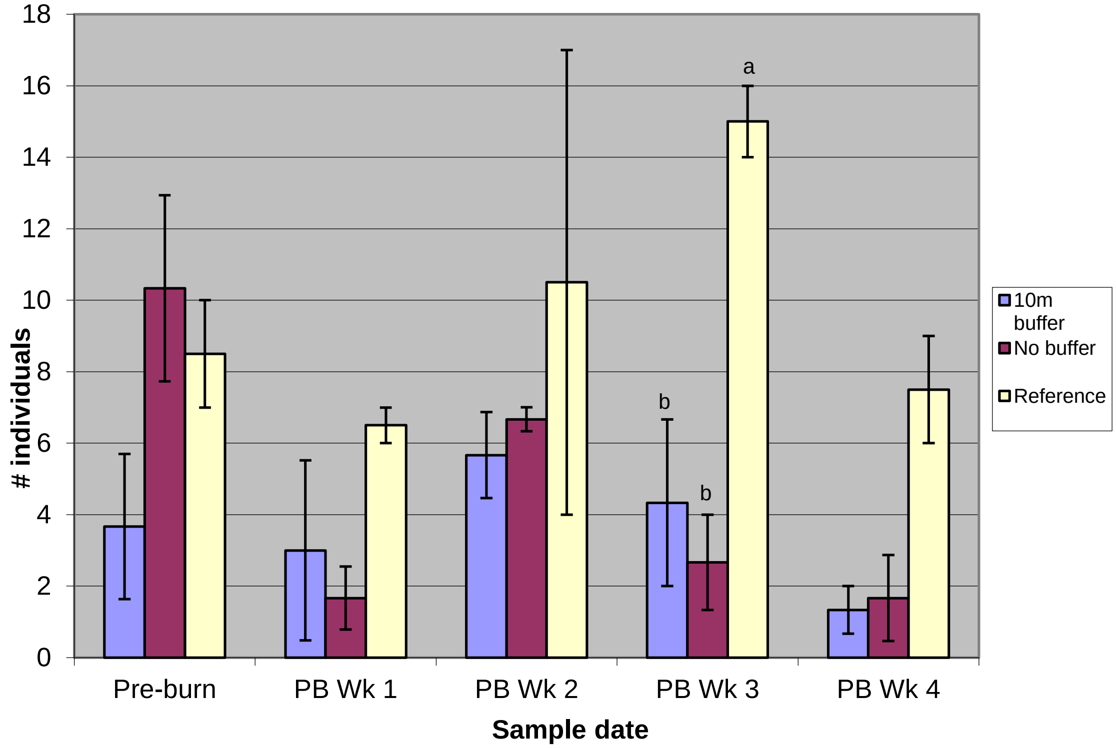


Figure 7: **Mean ± s.e.** of *Auchenorrhyncha* exhibiting significant effects (ANOVA) (p<.05) to presence (n=3) or absence (n=3) of 10M riparian buffer (riparian vegetation type: grass, trees or shrubs) in controlled burn of watershed surrounding ponds prior to controlled burn (pre-burn) on 3/18/09 and weekly (post-burn) for 4 weeks. A, B, and AB are implemented on samples dates where significance occurred, and display significant differences or similarities between treatments.

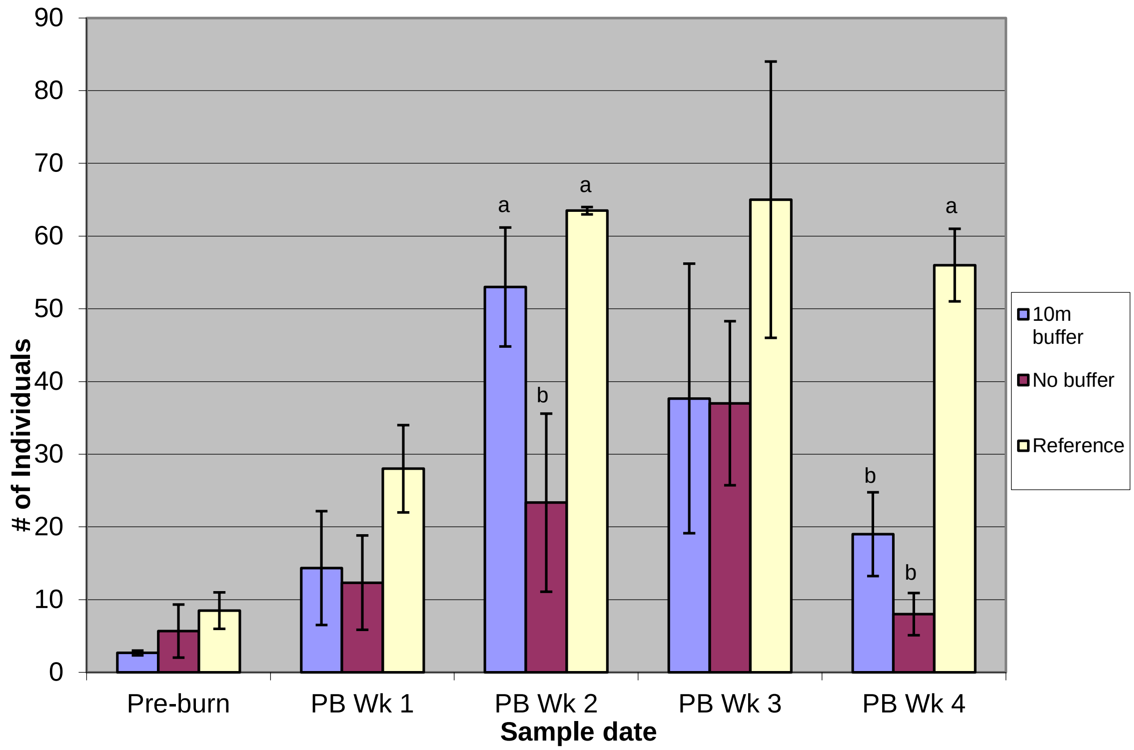
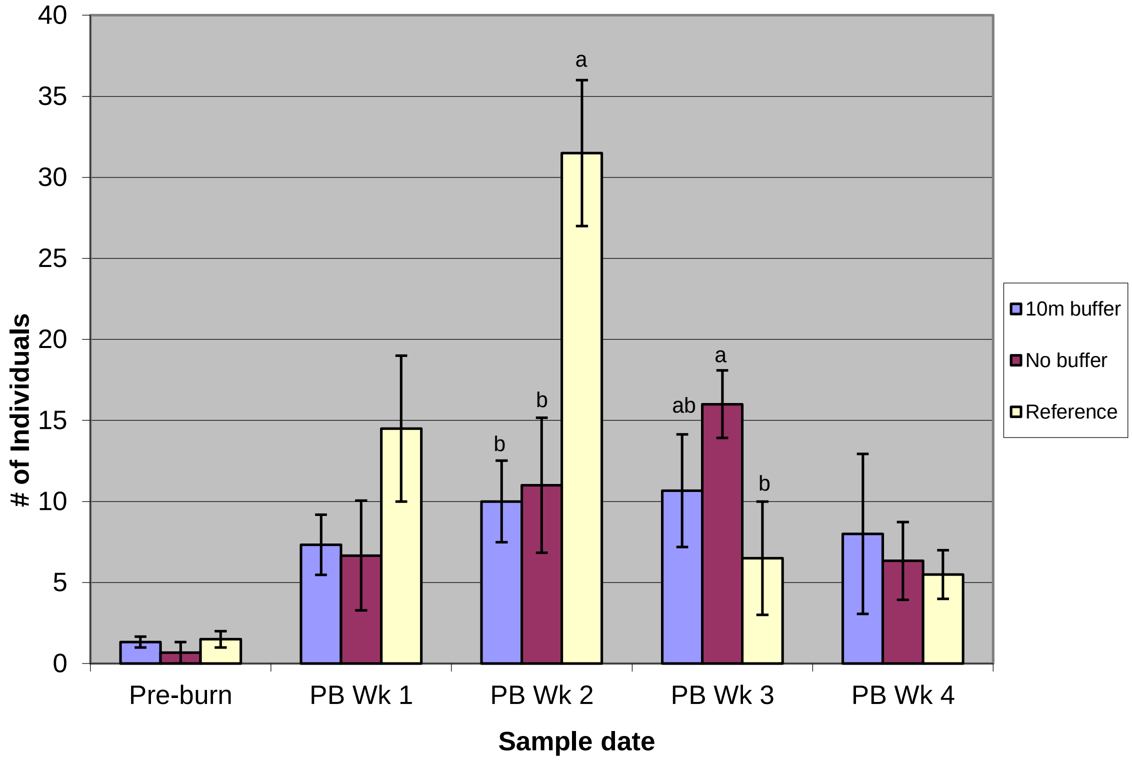
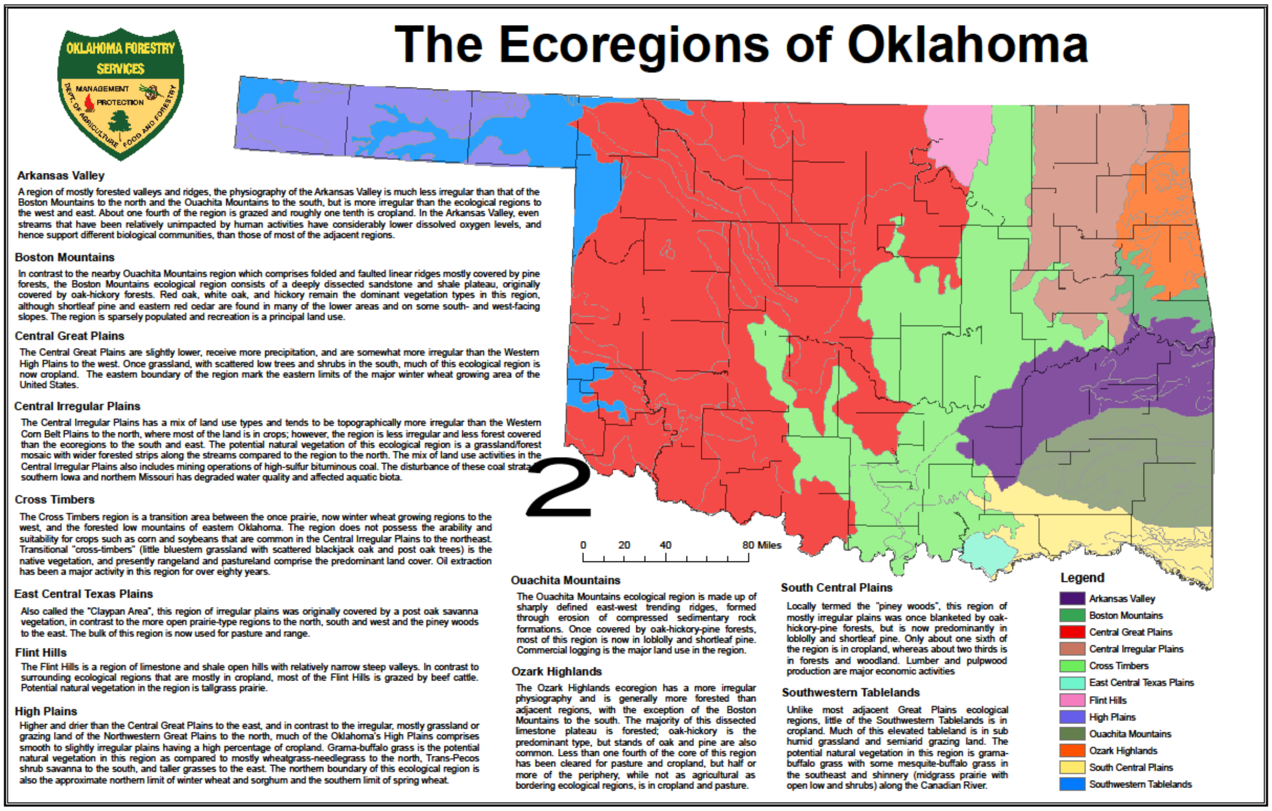


Figure 8: **Mean ± s.e.** of *Coleoptera* exhibiting significant effects (ANOVA) ($p<.05$) to presence ($n=3$) or absence ($n=3$) of 10M riparian buffer (riparian vegetation type: grass, trees or shrubs) in controlled burn of watershed surrounding ponds prior to controlled burn (pre-burn) on 3/18/09 and weekly (post-burn) for 4 weeks. A, B, and AB are implemented on samples dates where significance occurred, and display significant differences or similarities between treatments.



APPPENDICES



The Ecoregions of Oklahoma

OKLAHOMA FORESTRY SERVICES
MANAGEMENT
PROTECTION
DEPT. OF AGRICULTURE FOOD AND FORESTRY

Arkansas Valley

A region of mostly forested valleys and ridges, the physiography of the Arkansas Valley is much less irregular than that of the Boston Mountains to the north and the Ouachita Mountains to the south, but is more irregular than the ecological regions to the west and east. About one fourth of the region is grazed and roughly one tenth is cropland. In the Arkansas Valley, even streams that have been relatively unimpacted by human activities have considerably lower dissolved oxygen levels, and hence support different biological communities, than those of most of the adjacent regions.

Boston Mountains

In contrast to the nearby Ouachita Mountains region which comprises folded and faulted linear ridges mostly covered by pine forests, the Boston Mountains ecological region consists of a deeply dissected sandstone and shale plateau, originally covered by oak-hickory forests. Red oak, white oak, and hickory remain the dominant vegetation types in this region, although shortleaf pine and eastern red cedar are found in many of the lower areas and on some south- and west-facing slopes. The region is sparsely populated and recreation is a principal land use.

Central Great Plains

The Central Great Plains are slightly lower, receive more precipitation, and are somewhat more irregular than the Western High Plains to the west. Once grassland, with scattered low trees and shrubs in the south, much of this ecological region is now cropland. The eastern boundary of the region mark the eastern limits of the major winter wheat growing area of the United States.

Central Irregular Plains

The Central Irregular Plains has a mix of land use types and tends to be topographically more irregular than the Western Corn Belt Plains to the north, where most of the land is in crops; however, the region is less irregular and less forest covered than the ecoregions to the south and east. The potential natural vegetation of this ecological region is a grassland/forest mosaic with wider forested strips along the streams compared to the region to the north. The mix of land use activities in the Central Irregular Plains also includes mining operations of high-sulfur bituminous coal. The disturbance of these coal strata southern Iowa and northern Missouri has degraded water quality and affected aquatic biota.

Cross Timbers

The Cross Timbers region is a transition area between the once prairie, now winter wheat growing regions to the west, and the forested low mountains of eastern Oklahoma. The region does not possess the arability and suitability for crops such as corn and soybeans that are common in the Central Irregular Plains to the northeast. Transitional "cross-timbers" (little bluestem grassland with scattered blackjack oak and post oak trees) is the native vegetation, and presently rangeland and pastureland comprise the predominant land cover. Oil extraction has been a major activity in this region for over eighty years.

East Central Texas Plains

Also called the "Claypan Area", this region of irregular plains was originally covered by a post oak savanna vegetation, in contrast to the more open prairie-type regions to the north, south and west and the piney woods to the east. The bulk of this region is now used for pasture and range.

Flint Hills

The Flint Hills is a region of limestone and shale open hills with relatively narrow steep valleys. In contrast to surrounding ecological regions that are mostly in cropland, most of the Flint Hills is grazed by beef cattle. Potential natural vegetation in the region is tallgrass prairie.

High Plains

Higher and drier than the Central Great Plains to the east, and in contrast to the irregular, mostly grassland or grazing land of the Northwestern Great Plains to the north, much of the Oklahoma's High Plains comprises smooth to slightly irregular plains having a high percentage of cropland. Grama-buffalo grass is the potential natural vegetation in this region as compared to mostly wheatgrass-needlegrass to the north, Trans-Pecos shrub savanna to the south, and taller grasses to the east. The northern boundary of this ecological region is also the approximate northern limit of winter wheat and sorghum and the southern limit of spring wheat.

2

0 20 40 80 Miles

Ouachita Mountains

The Ouachita Mountains ecological region is made up of sharply defined east-west trending ridges, formed through erosion of compressed sedimentary rock formations. Once covered by oak-hickory-pine forests, most of this region is now in loblolly and shortleaf pine. Commercial logging is the major land use in the region.

Ozark Highlands

The Ozark Highlands ecoregion has a more irregular physiography and is generally more forested than adjacent regions, with the exception of the Boston Mountains to the south. The majority of this dissected limestone plateau is forested; oak-hickory is the predominant type, but stands of oak and pine are also common. Less than one fourth of the core of this region has been cleared for pasture and cropland, but half or more of the periphery, while not as agricultural as bordering ecological regions, is in cropland and pasture.

South Central Plains

Locally termed the "piney woods", this region of mostly irregular plains was once blanketed by oak-hickory-pine forests, but is now predominantly in loblolly and shortleaf pine. Only about one sixth of the region is in cropland, whereas about two thirds is in forests and woodland. Lumber and pulpwood production are major economic activities

Southwestern Tablelands

Unlike most adjacent Great Plains ecological regions, little of the Southwestern Tablelands is in cropland. Much of this elevated tableland is in sub humid grassland and semiarid grazing land. The potential natural vegetation in this region is grama-buffalo grass with some mesquite-buffalo grass in the southeast and shinnery (midgrass prairie with open low and shrubs) along the Canadian River.

Legend

- Arkansas Valley
- Boston Mountains
- Central Great Plains
- Central Irregular Plains
- Cross Timbers
- East Central Texas Plains
- Flint Hills
- High Plains
- Ouachita Mountains
- Ozark Highlands
- South Central Plains
- Southwestern Tablelands

For additional information contact Oklahoma Forestry Services at 405-522-6158 or www.forestry.ok.gov.

hab	time	trt	MNAbund		SEAbund
G	0	10mBuf	38.000	a	23.259
G	0	NoBuf	37.000	a	17.521
G	0	Ref	45.000	a	23.000
G	1	10mBuf	243.000	a	87.618
G	1	NoBuf	202.667	a	104.531
G	1	Ref	223.500	a	96.500
G	2	10mBuf	475.000	a	45.826
G	2	NoBuf	768.000	a	534.295
G	2	Ref	426.500	a	87.500
G	3	10mBuf	342.667	a	179.254
G	3	NoBuf	419.333	a	150.657
G	3	Ref	284.500	a	29.500
G	4	10mBuf	76.333	a	11.921
G	4	NoBuf	42.000	a	3.786
G	4	Ref	298.500	a	57.500
S	0	10mBuf	23.333	a	8.452
S	0	NoBuf	30.000	a	.
S	0	Ref	35.000	a	.
S	1	10mBuf	228.333	a	72.375
S	1	NoBuf	161.000	a	.
S	1	Ref	96.000	a	.
S	2	10mBuf	486.000	a	131.158
S	2	NoBuf	417.000	a	.
S	2	Ref	162.000	a	.
S	3	10mBuf	268.667	a	31.168
S	3	NoBuf	366.000	a	.
S	3	Ref	21.000	a	.
S	4	10mBuf	106.000	a	11.676
S	4	NoBuf	65.000	a	.
S	4	Ref	100.000	a	.
T	0	10mBuf	12.000	a	3.512
T	0	NoBuf	18.000	a	1.155
T	0	Ref	33.000	a	.
T	1	10mBuf	72.667	a	45.936
T	1	NoBuf	222.000	a	69.515
T	1	Ref	84.000	a	.
T	2	10mBuf	230.000	a	89.891
T	2	NoBuf	123.333	a	27.907
T	2	Ref	135.000	a	.
T	3	10mBuf	204.333	a	47.980
T	3	NoBuf	136.000	a	48.042
T	3	Ref	161.000	a	.
T	4	10mBuf	67.667	a	25.543
T	4	NoBuf	107.333	a	59.851
T	4	Ref	89.000	a	.

hab	time	trt	MNRichness		SERichness
G	0	10mBuf	11.6667	a	2.02759
G	0	NoBuf	11.3333	a	2.40370
G	0	Ref	17.5000	a	3.50000
G	1	10mBuf	25.0000	a	4.04145
G	1	NoBuf	19.0000	a	6.50641
G	1	Ref	28.0000	a	2.00000
G	2	10mBuf	32.0000	a	3.60555
G	2	NoBuf	30.6667	a	2.40370
G	2	Ref	36.0000	a	0.00000
G	3	10mBuf	28.6667	a	3.48010
G	3	NoBuf	24.3333	a	2.84800
G	3	Ref	34.0000	a	3.00000
G	4	10mBuf	17.6667	a	1.85592
G	4	NoBuf	14.3333	a	1.20185
G	4	Ref	24.0000	a	5.00000
S	0	10mBuf	10.3333	a	2.60342
S	0	NoBuf	11.0000	a	.
S	0	Ref	10.0000	a	.
S	1	10mBuf	29.3333	a	6.56591
S	1	NoBuf	27.0000	a	.
S	1	Ref	31.0000	a	.
S	2	10mBuf	37.6667	a	3.84419
S	2	NoBuf	40.0000	a	.
S	2	Ref	33.0000	a	.
S	**3**	**10mBuf**	**33.6667**	**a**	**5.23874**
S	**3**	**NoBuf**	**32.0000**	**a**	**.**
S	**3**	**Ref**	**8.0000**	**b**	**.**
S	4	10mBuf	27.0000	a	2.51661
S	4	NoBuf	21.0000	a	.
S	4	Ref	33.0000	a	.
T	0	10mBuf	6.6667	a	0.33333
T	0	NoBuf	10.6667	a	1.85592
T	0	Ref	14.0000	a	.
T	**1**	**10mBuf**	**14.0000**	**b**	**5.50757**
T	**1**	**NoBuf**	**33.3333**	**a**	**4.91031**
T	**1**	**Ref**	**25.0000**	**a**	**.**
T	2	10mBuf	32.3333	a	4.84195
T	2	NoBuf	27.0000	a	4.04145
T	2	Ref	29.0000	a	.
T	3	10mBuf	32.6667	a	4.84195
T	3	NoBuf	25.0000	a	2.08167
T	3	Ref	27.0000	a	.
T	4	10mBuf	24.0000	a	6.55744
T	4	NoBuf	22.6667	a	6.48931
T	4	Ref	26.0000	a	.

hab	time	trt	MNShannons		SEShannons
G	0	10mBuf	2.05097	a	0.15541
G	0	NoBuf	2.13017	a	0.12753
G	0	Ref	2.50928	a	0.11972
G	1	10mBuf	2.24902	a	0.18820
G	1	NoBuf	1.80650	a	0.22820
G	1	Ref	2.43036	a	0.00759
G	2	10mBuf	2.35783	a	0.31932
G	2	NoBuf	1.81405	a	0.48119
G	2	Ref	2.58265	a	0.20271
G	3	10mBuf	2.21433	a	0.28746
G	3	NoBuf	1.55807	a	0.29831
G	3	Ref	2.34693	a	0.25628
G	4	10mBuf	2.13602	a	0.20204
G	4	NoBuf	2.20891	a	0.10898
G	4	Ref	1.72102	a	0.56758
S	0	10mBuf	2.00521	a	0.21393
S	0	NoBuf	2.12767	a	.
S	0	Ref	1.71119	a	.
S	1	10mBuf	2.68931	a	0.16701
S	1	NoBuf	2.67259	a	.
S	1	Ref	2.89321	a	.
S	2	10mBuf	2.24991	a	0.30273
S	2	NoBuf	2.33655	a	.
S	2	Ref	2.96056	a	.
S	3	10mBuf	2.48156	a	0.32131
S	3	NoBuf	2.15601	a	.
S	3	Ref	1.72295	a	.
S	4	10mBuf	2.31940	a	0.34063
S	4	NoBuf	2.31678	a	.
S	4	Ref	2.87141	a	.
T	0	10mBuf	1.72550	a	0.09557
T	0	NoBuf	2.08983	a	0.19891
T	0	Ref	2.49303	a	.
T	1	10mBuf	2.06107	a	0.19024
T	1	NoBuf	2.75996	a	0.11347
T	1	Ref	2.58610	a	.
T	2	10mBuf	2.75026	a	0.16174
T	2	NoBuf	2.63153	a	0.14968
T	2	Ref	2.57704	a	.
T	3	10mBuf	2.50210	a	0.28598
T	3	NoBuf	2.51319	a	0.06492
T	3	Ref	2.25830	a	.
T	4	10mBuf	2.64536	a	0.35357
T	4	NoBuf	2.31093	a	0.24599
T	4	Ref	2.59307	a	.

hab	time	trt	MNeH		SEeH
G	0	10mBuf	7.9712	a	1.29072
G	0	NoBuf	8.5579	a	1.13298
G	0	Ref	12.3843	a	1.47564
G	1	10mBuf	9.8275	a	1.90412
G	1	NoBuf	6.3867	a	1.27010
G	1	Ref	11.3633	a	0.08622
G	2	10mBuf	11.6871	a	3.65664
G	2	NoBuf	7.7086	a	3.60142
G	2	Ref	13.5049	a	2.70071
G	3	10mBuf	9.9534	a	2.90128
G	3	NoBuf	5.1934	a	1.55418
G	3	Ref	10.7986	a	2.70840
G	4	10mBuf	8.8367	a	1.91022
G	4	NoBuf	9.2141	a	0.99785
G	4	Ref	6.5151	a	3.34601
S	0	10mBuf	7.7744	a	1.65491
S	0	NoBuf	8.3953	a	.
S	0	Ref	5.5356	a	.
S	1	10mBuf	15.1505	a	2.63731
S	1	NoBuf	14.4774	a	.
S	1	Ref	18.0511	a	.
S	2	10mBuf	10.4456	a	3.36553
S	2	NoBuf	10.3454	a	.
S	2	Ref	19.3087	a	.
S	3	10mBuf	13.1035	a	3.46847
S	3	NoBuf	8.6366	a	.
S	3	Ref	5.6010	a	.
S	4	10mBuf	11.5219	a	4.28729
S	4	NoBuf	10.1430	a	.
S	4	Ref	17.6619	a	.
T	0	10mBuf	5.6676	a	0.55349
T	0	NoBuf	8.3851	a	1.47736
T	0	Ref	12.0979	a	.
T	1	10mBuf	8.1508	a	1.60174
T	1	NoBuf	15.9969	a	1.72082
T	1	Ref	13.2778	a	.
T	2	10mBuf	16.0804	a	2.76610
T	2	NoBuf	14.2199	a	2.22499
T	2	Ref	13.1581	a	.
T	3	10mBuf	13.1398	a	3.17883
T	3	NoBuf	12.3973	a	0.82606
T	3	Ref	9.5668	a	.
T	4	10mBuf	15.7121	a	4.47870
T	4	NoBuf	10.6601	a	2.29632
T	4	Ref	13.3708	a	.

hab	time	trt	MNE1		SEE1
G	0	10mBuf	0.72945	a	0.15710
G	0	NoBuf	0.77978	a	0.05968
G	0	Ref	0.71959	a	0.05960
G	1	10mBuf	0.39493	a	0.03971
G	1	NoBuf	0.41457	a	0.11477
G	1	Ref	0.40769	a	0.02604
G	2	10mBuf	0.34949	a	0.07188
G	2	NoBuf	0.27287	a	0.14848
G	2	Ref	0.37514	a	0.07502
G	3	10mBuf	0.37531	a	0.15037
G	3	NoBuf	0.20632	a	0.04047
G	3	Ref	0.32718	a	0.10853
G	**4**	**10mBuf**	**0.49934**	**b**	**0.08215**
G	**4**	**NoBuf**	**0.64973**	**a**	**0.07692**
G	**4**	**Ref**	**0.25342**	**b**	**0.08662**
S	0	10mBuf	0.77186	a	0.04518
S	0	NoBuf	0.76321	a	.
S	0	Ref	0.55356	a	.
S	1	10mBuf	0.53577	a	0.07223
S	1	NoBuf	0.53620	a	.
S	1	Ref	0.58229	a	.
S	2	10mBuf	0.27520	a	0.07360
S	2	NoBuf	0.25864	a	.
S	2	Ref	0.58511	a	.
S	3	10mBuf	0.37378	a	0.05508
S	3	NoBuf	0.26989	a	.
S	3	Ref	0.70013	a	.
S	4	10mBuf	0.40633	a	0.11097
S	4	NoBuf	0.48300	a	.
S	4	Ref	0.53521	a	.
T	0	10mBuf	0.84823	a	0.05737
T	0	NoBuf	0.78546	a	0.01942
T	0	Ref	0.86414	a	.
T	1	10mBuf	0.67304	a	0.13490
T	1	NoBuf	0.49991	a	0.09103
T	1	Ref	0.53111	a	.
T	2	10mBuf	0.49432	a	0.01005
T	2	NoBuf	0.54824	a	0.09858
T	2	Ref	0.45373	a	.
T	3	10mBuf	0.38902	a	0.04630
T	3	NoBuf	0.50706	a	0.07140
T	3	Ref	0.35432	a	.
T	4	10mBuf	0.64989	a	0.01690
T	4	NoBuf	0.50399	a	0.10334
T	4	Ref	0.51426	a	.

hab	time	trt	MNDipt		SEDipt
G	0	10mBuf	21.667	a	20.1687
G	0	NoBuf	6.333	a	1.8559
G	0	Ref	14.000	a	12.0000
G	1	10mBuf	110.000	a	50.7182
G	1	NoBuf	40.333	a	25.6667
G	1	Ref	36.000	a	21.0000
G	**2**	**10mBuf**	**104.333**	**a**	**45.7323**
G	**2**	**NoBuf**	**14.000**	**b**	**2.3094**
G	**2**	**Ref**	**68.000**	**ab**	**37.0000**
G	3	10mBuf	32.667	a	16.7066
G	3	NoBuf	32.000	a	18.1751
G	3	Ref	44.000	a	22.0000
G	4	10mBuf	3.333	a	2.8480
G	4	NoBuf	3.667	a	0.6667
G	4	Ref	17.500	a	11.5000
S	0	10mBuf	5.667	a	5.1747
S	0	NoBuf	7.000	a	.
S	0	Ref	3.000	a	.
S	1	10mBuf	128.667	a	50.3466
S	1	NoBuf	50.000	a	.
S	1	Ref	32.000	a	.
S	2	10mBuf	103.667	a	37.5514
S	2	NoBuf	103.000	a	.
S	2	Ref	46.000	a	.
S	3	10mBuf	65.667	a	28.3392
S	3	NoBuf	84.000	a	.
S	3	Ref	3.000	a	.
S	4	10mBuf	18.000	a	6.0277
S	4	NoBuf	7.000	a	.
S	4	Ref	10.000	a	.
T	0	10mBuf	0.667	a	0.3333
T	0	NoBuf	5.000	a	2.5166
T	0	Ref	13.000	a	.
T	1	10mBuf	42.667	a	29.1338
T	1	NoBuf	69.333	a	30.3333
T	1	Ref	25.000	a	.
T	2	10mBuf	73.667	a	44.1261
T	2	NoBuf	22.667	a	5.3645
T	2	Ref	25.000	a	.
T	3	10mBuf	57.667	a	31.6351
T	3	NoBuf	25.333	a	10.8372
T	3	Ref	37.000	a	.
T	4	10mBuf	20.000	a	9.2376
T	4	NoBuf	21.667	a	15.7092
T	4	Ref	10.000	a	.

hab	time	trt	MNDNem		SEDNem
G	0	10mBuf	20.333	a	19.8354
G	0	NoBuf	3.667	a	0.3333
G	0	Ref	10.500	a	10.5000
G	**1**	**10mBuf**	**95.333**	**a**	**47.3439**
G	**1**	**NoBuf**	**26.667**	**b**	**17.2659**
G	**1**	**Ref**	**17.000**	**b**	**10.0000**
G	2	10mBuf	55.333	a	26.4407
G	2	NoBuf	8.000	a	0.5774
G	2	Ref	37.500	a	28.5000
G	3	10mBuf	10.000	a	1.5275
G	3	NoBuf	14.667	a	12.6798
G	3	Ref	25.000	a	18.0000
G	4	10mBuf	2.667	a	2.1858
G	4	NoBuf	1.333	a	0.8819
G	4	Ref	9.500	a	8.5000
S	0	10mBuf	5.333	a	5.3333
S	0	NoBuf	2.000	a	.
S	0	Ref	2.000	a	.
S	**1**	**10mBuf**	**113.000**	**a**	**47.0142**
S	**1**	**NoBuf**	**21.000**	**b**	**.**
S	**1**	**Ref**	**25.000**	**b**	**.**
S	2	10mBuf	42.000	a	13.4536
S	2	NoBuf	15.000	a	.
S	2	Ref	34.000	a	.
S	3	10mBuf	40.667	a	19.9360
S	3	NoBuf	18.000	a	.
S	3	Ref	1.000	a	.
S	4	10mBuf	9.667	a	6.6916
S	4	NoBuf	1.000	a	.
S	4	Ref	4.000	a	.
T	0	10mBuf	0.667	a	0.3333
T	0	NoBuf	4.667	a	2.7285
T	0	Ref	8.000	a	.
T	1	10mBuf	36.667	a	25.6407
T	1	NoBuf	47.667	a	22.0025
T	1	Ref	18.000	a	.
T	2	10mBuf	51.667	a	34.7435
T	2	NoBuf	10.000	a	3.6056
T	2	Ref	15.000	a	.
T	3	10mBuf	47.000	a	29.3995
T	3	NoBuf	18.000	a	9.7125
T	3	Ref	18.000	a	.
T	4	10mBuf	6.000	a	3.0000
T	4	NoBuf	12.667	a	11.6667
T	4	Ref	1.000	a	.

hab	time	trt	MNDbrach		SEDbrach
G	0	10mBuf	1.3333	a	0.6667
G	0	NoBuf	2.6667	a	1.7638
G	0	Ref	3.5000	a	1.5000
G	1	10mBuf	14.6667	a	5.2387
G	1	NoBuf	13.6667	a	8.4130
G	1	Ref	19.0000	a	11.0000
G	**2**	**10mBuf**	**49.0000**	**a**	**19.3132**
G	**2**	**NoBuf**	**6.0000**	**b**	**1.7321**
G	**2**	**Ref**	**30.5000**	**ab**	**8.5000**
G	3	10mBuf	22.6667	a	15.6667
G	3	NoBuf	17.3333	a	7.3106
G	3	Ref	19.0000	a	4.0000
G	4	10mBuf	0.6667	a	0.6667
G	4	NoBuf	2.3333	a	1.2019
G	4	Ref	8.0000	a	3.0000
S	0	10mBuf	0.3333	a	0.3333
S	0	NoBuf	5.0000	a	.
S	0	Ref	1.0000	a	.
S	1	10mBuf	15.6667	a	3.3333
S	1	NoBuf	29.0000	a	.
S	1	Ref	7.0000	a	.
S	**2**	**10mBuf**	**61.6667**	**a**	**30.0241**
S	**2**	**NoBuf**	**88.0000**	**a**	**.**
S	**2**	**Ref**	**12.0000**	**b**	**.**
S	**3**	**10mBuf**	**25.0000**	**b**	**11.0604**
S	**3**	**NoBuf**	**66.0000**	**a**	**.**
S	**3**	**Ref**	**2.0000**	**b**	**.**
S	4	10mBuf	8.3333	a	1.3333
S	4	NoBuf	6.0000	a	.
S	4	Ref	6.0000	a	.
T	0	10mBuf	0.0000	a	0.0000
T	0	NoBuf	0.3333	a	0.3333
T	0	Ref	5.0000	a	.
T	1	10mBuf	6.0000	a	3.5119
T	1	NoBuf	21.6667	a	8.5114
T	1	Ref	7.0000	a	.
T	2	10mBuf	22.0000	a	9.8658
T	2	NoBuf	12.6667	a	5.9255
T	2	Ref	10.0000	a	.
T	3	10mBuf	10.6667	a	2.8480
T	3	NoBuf	7.3333	a	2.1858
T	3	Ref	19.0000	a	.
T	4	10mBuf	14.0000	a	6.8069
T	4	NoBuf	9.0000	a	4.1633
T	4	Ref	9.0000	a	.

hab	time	trt	MNArane		SEArane
G	0	10mBuf	3.6667	a	2.02759
G	0	NoBuf	10.3333	a	2.60342
G	0	Ref	8.5000	a	1.50000
G	1	10mBuf	3.0000	a	2.51661
G	1	NoBuf	1.6667	a	0.88192
G	1	Ref	6.5000	a	0.50000
G	2	10mBuf	5.6667	a	1.20185
G	2	NoBuf	6.6667	a	0.33333
G	2	Ref	10.5000	a	6.50000
G	**3**	**10mBuf**	**4.3333**	**b**	**2.33333**
G	**3**	**NoBuf**	**2.6667**	**b**	**1.33333**
G	**3**	**Ref**	**15.0000**	**a**	**1.00000**
G	4	10mBuf	1.3333	a	0.66667
G	4	NoBuf	1.6667	a	1.20185
G	4	Ref	7.5000	a	1.50000
S	0	10mBuf	6.0000	a	3.00000
S	0	NoBuf	14.0000	a	.
S	0	Ref	4.0000	a	.
S	1	10mBuf	6.6667	a	2.90593
S	1	NoBuf	11.0000	a	.
S	1	Ref	8.0000	a	.
S	2	10mBuf	10.3333	a	1.66667
S	2	NoBuf	5.0000	a	.
S	2	Ref	8.0000	a	.
S	3	10mBuf	11.6667	a	1.20185
S	3	NoBuf	8.0000	a	.
S	3	Ref	0.0000	a	.
S	4	10mBuf	5.0000	a	2.30940
S	4	NoBuf	2.0000	a	.
S	4	Ref	4.0000	a	.
T	0	10mBuf	2.3333	a	1.33333
T	0	NoBuf	3.0000	a	3.00000
T	0	Ref	8.0000	a	.
T	1	10mBuf	3.6667	a	3.17980
T	1	NoBuf	7.3333	a	2.02759
T	1	Ref	8.0000	a	.
T	2	10mBuf	6.6667	a	2.18581
T	2	NoBuf	8.3333	a	1.20185
T	2	Ref	12.0000	a	.
T	3	10mBuf	4.6667	a	0.66667
T	3	NoBuf	11.3333	a	5.33333
T	3	Ref	14.0000	a	.
T	4	10mBuf	4.3333	a	2.96273
T	4	NoBuf	8.3333	a	4.05518
T	4	Ref	6.0000	a	.

hab	time	trt	MNAphid		SEAphid
G	0	10mBuf	0.0000	a	0.0000
G	0	NoBuf	0.3333	a	0.3333
G	0	Ref	0.0000	a	0.0000
G	1	10mBuf	18.3333	a	9.2436
G	1	NoBuf	24.6667	a	23.6737
G	1	Ref	19.0000	a	19.0000
G	2	10mBuf	26.6667	a	18.5502
G	2	NoBuf	65.6667	a	62.6667
G	2	Ref	23.5000	a	23.5000
G	3	10mBuf	18.3333	a	16.3435
G	3	NoBuf	15.0000	a	9.0738
G	3	Ref	13.5000	a	10.5000
G	4	10mBuf	3.0000	a	0.0000
G	4	NoBuf	1.3333	a	1.3333
G	4	Ref	8.0000	a	7.0000
S	0	10mBuf	0.0000	a	0.0000
S	0	NoBuf	0.0000	a	.
S	0	Ref	0.0000	a	.
S	1	10mBuf	11.3333	a	7.4237
S	1	NoBuf	9.0000	a	.
S	1	Ref	0.0000	a	.
S	2	10mBuf	35.0000	a	17.5784
S	2	NoBuf	19.0000	a	.
S	2	Ref	1.0000	a	.
S	3	10mBuf	30.6667	a	24.2097
S	3	NoBuf	9.0000	a	.
S	3	Ref	1.0000	a	.
S	4	10mBuf	1.6667	a	0.8819
S	4	NoBuf	2.0000	a	.
S	4	Ref	5.0000	a	.
T	0	10mBuf	0.0000	a	0.0000
T	0	NoBuf	0.0000	a	0.0000
T	0	Ref	0.0000	a	.
T	1	10mBuf	2.0000	a	2.0000
T	1	NoBuf	6.0000	a	2.8868
T	1	Ref	2.0000	a	.
T	2	10mBuf	17.0000	a	14.0475
T	2	NoBuf	4.0000	a	1.5275
T	2	Ref	1.0000	a	.
T	3	10mBuf	11.0000	a	2.0817
T	3	NoBuf	4.3333	a	3.8442
T	3	Ref	2.0000	a	.
T	4	10mBuf	1.3333	a	0.8819
T	4	NoBuf	2.0000	a	1.5275
T	4	Ref	3.0000	a	.

hab	time	trt	MNHop		SEHop
G	0	10mBuf	2.6667	a	0.3333
G	0	NoBuf	5.6667	a	3.6667
G	0	Ref	8.5000	a	2.5000
G	1	10mBuf	14.3333	a	7.8387
G	1	NoBuf	12.3333	a	6.4893
G	1	Ref	28.0000	a	6.0000
G	**2**	**10mBuf**	**53.0000**	**a**	**8.1854**
G	**2**	**NoBuf**	**23.3333**	**b**	**12.2520**
G	**2**	**Ref**	**63.5000**	**a**	**0.5000**
G	3	10mBuf	37.6667	a	18.5502
G	3	NoBuf	37.0000	a	11.2694
G	3	Ref	65.0000	a	19.0000
G	**4**	**10mBuf**	**19.0000**	**b**	**5.7735**
G	**4**	**NoBuf**	**8.0000**	**b**	**2.8868**
G	**4**	**Ref**	**56.0000**	**a**	**5.0000**
S	0	10mBuf	2.3333	a	0.3333
S	0	NoBuf	1.0000	a	.
S	0	Ref	6.0000	a	.
S	1	10mBuf	10.0000	a	9.0000
S	1	NoBuf	16.0000	a	.
S	1	Ref	8.0000	a	.
S	2	10mBuf	33.6667	a	15.4955
S	2	NoBuf	3.0000	a	.
S	2	Ref	11.0000	a	.
S	3	10mBuf	17.0000	a	3.0551
S	3	NoBuf	41.0000	a	.
S	3	Ref	3.0000	a	.
S	4	10mBuf	29.6667	a	13.1698
S	4	NoBuf	19.0000	a	.
S	4	Ref	17.0000	a	.
T	0	10mBuf	1.3333	a	1.3333
T	0	NoBuf	2.6667	a	2.1858
T	0	Ref	6.0000	a	.
T	1	10mBuf	0.0000	a	0.0000
T	1	NoBuf	10.3333	a	2.3333
T	1	Ref	3.0000	a	.
T	2	10mBuf	17.6667	a	8.2932
T	2	NoBuf	14.0000	a	2.5166
T	2	Ref	18.0000	a	.
T	3	10mBuf	24.3333	a	6.4893
T	3	NoBuf	14.3333	a	6.6916
T	3	Ref	4.0000	a	.
T	4	10mBuf	12.3333	a	2.0276
T	4	NoBuf	19.0000	a	6.5574
T	4	Ref	13.0000	a	.

hab	time	trt	MNThrip		SEThrip
G	0	10mBuf	0.000	a	0.000
G	0	NoBuf	0.667	a	0.667
G	0	Ref	0.500	a	0.500
G	1	10mBuf	1.000	a	0.000
G	1	NoBuf	4.000	a	2.309
G	1	Ref	2.500	a	0.500
G	2	10mBuf	46.667	a	12.333
G	2	NoBuf	51.333	a	27.236
G	2	Ref	17.000	a	9.000
G	3	10mBuf	22.333	a	10.203
G	3	NoBuf	8.667	a	4.256
G	3	Ref	8.500	a	4.500
G	4	10mBuf	0.667	a	0.667
G	4	NoBuf	0.667	a	0.667
G	4	Ref	6.000	a	1.000
S	0	10mBuf	0.333	a	0.333
S	0	NoBuf	0.000	a	.
S	0	Ref	1.000	a	.
S	1	10mBuf	3.667	a	2.186
S	1	NoBuf	11.000	a	.
S	1	Ref	0.000	a	.
S	**2**	**10mBuf**	**150.000**	**a**	**142.011**
S	**2**	**NoBuf**	**33.000**	**b**	**.**
S	**2**	**Ref**	**4.000**	**b**	**.**
S	3	10mBuf	11.000	a	6.807
S	3	NoBuf	14.000	a	.
S	3	Ref	0.000	a	.
S	4	10mBuf	1.000	a	0.577
S	4	NoBuf	1.000	a	.
S	4	Ref	0.000	a	.
T	0	10mBuf	0.000	a	0.000
T	0	NoBuf	0.000	a	0.000
T	0	Ref	0.000	a	.
T	1	10mBuf	2.333	a	1.202
T	1	NoBuf	2.667	a	1.202
T	1	Ref	1.000	a	.
T	2	10mBuf	40.000	a	19.519
T	2	NoBuf	2.333	a	0.882
T	2	Ref	2.000	a	.
T	3	10mBuf	17.000	a	17.000
T	3	NoBuf	1.000	a	1.000
T	3	Ref	0.000	a	.
T	4	10mBuf	1.333	a	0.333
T	4	NoBuf	2.667	a	2.667
T	4	Ref	1.000	a	.

hab	time	trt	MNHColeop	SEHColeop
G	0	10mBuf	1.3333 a	0.33333
G	0	NoBuf	0.6667 a	0.66667
G	0	Ref	1.5000 a	0.50000
G	1	10mBuf	7.3333 a	1.85592
G	1	NoBuf	6.6667 a	3.38296
G	1	Ref	14.5000 a	4.50000
G	**2**	**10mBuf**	**10.0000 b**	**2.51661**
G	**2**	**NoBuf**	**11.0000 b**	**4.16333**
G	**2**	**Ref**	**31.5000 a**	**4.50000**
G	**3**	**10mBuf**	**10.6667 ab**	**3.48010**
G	**3**	**NoBuf**	**16.0000 a**	**2.08167**
G	**3**	**Ref**	**6.5000 b**	**3.50000**
G	4	10mBuf	8.0000 a	4.93288
G	4	NoBuf	6.3333 a	2.40370
G	4	Ref	5.5000 a	1.50000
S	0	10mBuf	2.0000 a	1.00000
S	0	NoBuf	1.0000 a	.
S	0	Ref	5.0000 a	.
S	1	10mBuf	6.0000 a	1.52753
S	1	NoBuf	7.0000 a	.
S	1	Ref	2.0000 a	.
S	2	10mBuf	5.0000 a	0.57735
S	2	NoBuf	7.0000 a	.
S	2	Ref	10.0000 a	.
S	3	10mBuf	5.6667 a	1.66667
S	3	NoBuf	4.0000 a	.
S	3	Ref	0.0000 a	.
S	**4**	**10mBuf**	**9.0000 b**	**2.51661**
S	**4**	**NoBuf**	**5.0000 b**	**.**
S	**4**	**Ref**	**30.0000 a**	**.**
T	0	10mBuf	2.0000 a	1.00000
T	0	NoBuf	1.0000 a	0.00000
T	0	Ref	0.0000 a	.
T	1	10mBuf	1.0000 a	1.00000
T	1	NoBuf	6.3333 a	2.02759
T	1	Ref	7.0000 a	.
T	2	10mBuf	4.0000 a	1.73205
T	2	NoBuf	2.3333 a	0.88192
T	2	Ref	8.0000 a	.
T	3	10mBuf	4.6667 a	1.66667
T	3	NoBuf	2.3333 a	0.33333
T	3	Ref	9.0000 a	.
T	**4**	**10mBuf**	**3.6667 b**	**0.88192**
T	**4**	**NoBuf**	**3.6667 b**	**0.66667**
T	**4**	**Ref**	**14.0000 a**	**.**

hab	time	trt	MNPhym		SEPhym
G	0	10mBuf	2.6667	a	0.8819
G	0	NoBuf	7.6667	a	6.1734
G	0	Ref	5.0000	a	4.0000
G	1	10mBuf	18.3333	a	7.8387
G	1	NoBuf	8.3333	a	4.4845
G	1	Ref	12.5000	a	3.5000
G	2	10mBuf	26.6667	a	22.1836
G	2	NoBuf	15.6667	a	4.9103
G	2	Ref	29.5000	a	8.5000
G	3	10mBuf	17.6667	a	10.2035
G	3	NoBuf	5.0000	a	2.5166
G	3	Ref	20.0000	a	15.0000
G	4	10mBuf	0.6667	a	0.3333
G	4	NoBuf	0.6667	a	0.3333
G	4	Ref	7.5000	a	2.5000
S	0	10mBuf	1.6667	a	0.8819
S	0	NoBuf	2.0000	a	.
S	0	Ref	0.0000	a	.
S	1	10mBuf	16.0000	a	2.6458
S	1	NoBuf	6.0000	a	.
S	1	Ref	3.0000	a	.
S	2	10mBuf	32.3333	a	11.0202
S	2	NoBuf	30.0000	a	.
S	2	Ref	9.0000	a	.
S	3	10mBuf	13.0000	a	10.5357
S	3	NoBuf	19.0000	a	.
S	3	Ref	0.0000	a	.
S	4	10mBuf	1.0000	a	0.5774
S	4	NoBuf	5.0000	a	.
S	4	Ref	3.0000	a	.
T	0	10mBuf	0.3333	a	0.3333
T	0	NoBuf	1.3333	a	0.8819
T	0	Ref	3.0000	a	.
T	1	10mBuf	2.6667	a	1.2019
T	1	NoBuf	18.6667	a	3.2830
T	1	Ref	5.0000	a	.
T	2	10mBuf	10.6667	a	4.9103
T	2	NoBuf	10.6667	a	1.4530
T	2	Ref	18.0000	a	.
T	3	10mBuf	12.3333	a	3.3830
T	3	NoBuf	9.6667	a	5.9255
T	3	Ref	14.0000	a	.
T	4	10mBuf	6.6667	a	3.7565
T	4	NoBuf	5.0000	a	4.5092
T	4	Ref	3.0000	a	.

hab	time	trt	MNForm		SEForm
G	0	10mBuf	3.667	a	2.333
G	0	NoBuf	1.667	a	1.202
G	0	Ref	3.000	a	2.000
G	1	10mBuf	51.333	a	21.341
G	1	NoBuf	91.000	a	42.454
G	1	Ref	75.000	a	40.000
G	2	10mBuf	144.667	b	72.188
G	2	NoBuf	547.000	a	421.920
G	2	Ref	123.000	b	1.000
G	3	10mBuf	161.333	a	87.473
G	3	NoBuf	281.667	a	133.362
G	3	Ref	81.000	a	46.000
G	4	10mBuf	24.667	a	11.681
G	4	NoBuf	10.667	a	3.180
G	4	Ref	166.500	a	82.500
S	0	10mBuf	3.667	a	2.333
S	0	NoBuf	5.000	a	.
S	0	Ref	16.000	a	.
S	1	10mBuf	31.667	a	6.839
S	1	NoBuf	42.000	a	.
S	1	Ref	21.000	a	.
S	2	10mBuf	92.333	a	30.563
S	2	NoBuf	182.000	a	.
S	2	Ref	5.000	a	.
S	3	10mBuf	81.667	a	30.552
S	3	NoBuf	165.000	a	.
S	3	Ref	2.000	a	.
S	4	10mBuf	23.667	a	21.169
S	4	NoBuf	17.000	a	.
S	4	Ref	9.000	a	.
T	0	10mBuf	1.667	a	0.333
T	0	NoBuf	3.000	a	1.155
T	0	Ref	0.000	a	.
T	1	10mBuf	10.000	a	4.933
T	1	NoBuf	66.000	a	25.166
T	1	Ref	27.000	a	.
T	2	10mBuf	26.667	a	4.910
T	2	NoBuf	19.000	a	6.928
T	2	Ref	38.000	a	.
T	3	10mBuf	49.000	a	9.713
T	3	NoBuf	37.333	a	14.621
T	3	Ref	71.000	a	.
T	4	10mBuf	4.667	a	2.028
T	4	NoBuf	37.333	a	25.115
T	4	Ref	26.000	a	.

Date	Location	MXTMP	MNTMP	AVGTMP	AVGDP	AVGRH	DRF
3/18/2009	Stillwater	81.5	55.3	67.1	45.5	49.1	0
4/8/2009	Stillwater	77.3	32.8	58.5	29.2	39.6	0
4/15/2009	Stillwater	75.6	46.9	61.8	43.1	53.2	0
4/22/2009	Stillwater	93.2	53.6	75.2	47.8	43.5	0
4/29/2009	Stillwater	69.6	56.8	64.1	61	89.6	1.1
5/6/2009	Stillwater	78.2	58.1	65.6	60	83.6	0.02

MXTMP	Maximum temperature (°F)
MNTMP	Minimum temperature (°F)
AVGTMP	Average temperature (°F)
AVGDP	Average dew point
AVGRH	Average relative humidity
PWD	Primary wind direction
PWDF	Primary wind direction frequency
SWD	Secondary wind direction
SWDF	Secondary wind direction frequency
MXWS	Maximum wind speed (mph)
MNWS	Minimum wind speed (mph)
AVGWS	Average wind speed (mph)
DRF	Daily rainfall (inches)

Date	Location	PWD	PWDF	SWD	SWDF	MXWS	MNWS	AVGWS
3/18/2009	Stillwater	6	22.8	8	11.9	24.6	0.94	9.23
4/8/2009	Stillwater	0	-	0	-	14.9	0	7.3
4/15/2009	Stillwater	5	52.4	6	37.15	17.5	2.3	10.8
4/22/2009	Stillwater	0	-	0	-	14.7	0	6.2
4/29/2009	Stillwater	6	30.2	7	25.4	26.2	2.9	7.6
5/6/2009	Stillwater	0	-	0	-	11.4	0	4.3

MXTMP	Maximum temperature (°F)	Wind Direction:	
MNTMP	Minimum temperature (°F)	0	Calm wind
AVGTMP	Average temperature (°F)	5	E
AVGDP	Average dew point	6	ESE
AVGRH	Average relative humidity	7	SE
PWD	Primary wind direction	8	SSE
PWDF	Primary wind direction frequency		
SWD	Secondary wind direction		
SWDF	Secondary wind direction frequency		
MXWS	Maximum wind speed (mph)		
MNWS	Minimum wind speed (mph)		
AVGWS	Average wind speed (mph)		
DRF	Daily rainfall (inches)		

	Pre-burn																			
	Reference Sites				**No Riparian Buffer**							**10 meter Riparian Buffer**								
	ENTO		Sect 4 West		SW Past NE		NE Past		JY Middle			SW Past West			SW Past East			Wheatgrass		
Taxa	Grass	Trees	Grass	Shrubs	Grass	Trees	Grass	Trees	Grass	Trees	Shrubs	Grass	Trees	Shrubs	Grass	Trees	Shrubs	Grass	Trees	Shrubs
Diptera																				
Nematocera																				
Tipulidae																				
Bibionidae				1																
Sciaroidea																				
Mycetophilidae					1					1										
Sciaridae		1	4	1		2	4	1		2	2	5	1	4	1	1				
Cecidomyiidae					2				4											
Psychodidae																				
Chironomoidea																				
Ceratopogonidae		4	4			2						19		4						
Chironomidae		3	13			6						36		8						
Culicidae																				
Brachycera																				
Empididae																				
Dolichopodidae		1																		
Phoridae	1				1						4									
Otitidae																				
Tephritidae																				
Agromyzidae																				
Lauxaniidae																				
Chamaemyiidae												1								
Drosophilidae																				
Ephydridae			1															1		
Chloropidae			3		1		4				1									
Scathophagidae		2																		
Anthomyzidae				1																
Muscidae																				
Tachinidae																				
Platypezidae																				
Syrphidae																				
Curtonotidae																				
Tabanidae																				
Lonchaeidae																				
Asteiidae																				
Milichiidae																				
Scatopsidae							1											1		
Un-ID'ed		2	1				1	1				1								1
Araneae																				
Araneidae			3	1				1									1			
Linyphiidae			2		6		12	2	5	1		1						1	1	
Nesticidae																				
Dictynidae		1								1	8			1						
Clubionidae																				
Philodromidae	1		2					4	2		3								1	1
Salticidae	3	3	3	2			2	3	3	5	3	4		2	3		1	1	3	8
Thomisidae												1								
Oxyopidae																				
Pisauridae																				
Lycosidae	1	2		1						2										2
Mimetidae																	1			
Hahniidae	2	2																		
Miturgidae																				
Agelenidae																				
Un-ID'ed							1					1	1		1	1				1
Collembola	1		1					1												
Odonata																				
Anisoptera																				
Zygoptera																				
Orthoptera																				
Gryllidae									1											
Caelifera			1												1					
Hemiptera																				
Aphididae							10													
Hoppers	6	6	11	6	2		13	7	2	1	1	3		2	3	4	3	2		2
Tingidae						1				1					1					
Berytidae																				
Pentatomidae			1												1					
Lygaeidae					1	1	5							2	2				7	
Rhopalidae			1																	
Miridae																				
Nabidae																				
Reduviidae																				
Un-ID'ed																				
Thysanoptera	1			1			2							1						

	Pre-burn																			
	Reference Sites				No Riparian Buffer							10 meter Riparian Buffer								
	ENTO		Sect 4 West		SW Past NE		NE Past		JY Middle			SW Past West			SW Past East			Wheatgrass		
Taxa	Grass	Trees	Grass	Shrubs	Grass	Trees	Grass	Trees	Grass	Trees	Shrubs	Grass	Trees	Shrubs	Grass	Trees	Shrubs	Grass	Trees	Shrubs
Psocoptera	1		1														1			1
Coleoptera						1														
Buprestidae												1			1					2
Carabidae																				
Cantharidae																				
Curculionidae	1		1				1			1				1						
Chrysomelidae			1	5									1	1	1				4	
Scolytidae																				1
Elateridae																				
Mordellidae																				
Staphylinidae																				
Lampyridae																				
Languriidae																				
Coccinellidae																				
Meloidae																				
Tenebrionidae																				
Nitidulidae																				
Haliplidae																				
Un-ID'ed							1	1			1			1		1		1		
Neuroptera																				
Hemerobiidae																			1	
Myrmeleontidae																				
Hymenoptera																				
Ichneumonoidea	1	3	10				9	2	1		1			2				3		
Chalcidoidea			8		2		11	1		1	1	1	1	1	3			1		2
Formicidae	1		5	16	10	5	4	1		3	5	8	2	8	3	1	3		2	
Apidae																				
Un-ID'ed													1							
Lepidoptera																				
Adults												1		1		1				
Caterpillars													1							
Siphonaptera																				
Acari																				
Mites					1				3			1								
Opilliones		2						1		1										
Ixodidae																				
Ticks																				
Isopoda																				
Blattaria																				
Isoptera																				
Mantodea																				
Phasmantodea																				
Snails																				
Millipede																				
Un ID'ed	1	1																		

	Post burn Week 1																			
	Reference Sites				No Riparian Buffer							10 meter Riparian Buffer								
	ENTO		Sect 4 West		SW Past NE		NE Past		JY Middle			SW Past West			SW Past East			Wheatgrass		
Taxa	Grass	Trees	Grass	Shrubs	Grass	Trees	Grass	Trees	Grass	Trees	Shrubs	Grass	Trees	Shrubs	Grass	Trees	Shrubs	Grass	Trees	Shrubs
Diptera																				
Nematocera																				
Tipulidae			3	9		11					1		1				1			
Bibionidae										2							7			
Sciaroidea					1	3									2		3	1		1
Mycetophilidae				1	1										2		12	13		
Sciaridae	2	4	24	11	1	12		7	11	25	20	13	2	7	6		17	4	4	5
Cecidomyiidae		1		1	31	10			2		1				24		23	3		11
Psychodidae					1					2	1						12			
Chironomoidea					1	2									5		7	12	6	12
Ceratopogonidae	3	2		1	7	23		1		10	14			4	18	11	36	90	18	57
Chironomidae	2	11		2	16	31			8	21	2			8	39	9	41	135	59	72
Culicidae						1											3			
Brachycera																				
Empididae						4				1							1			
Dolichopodidae		1	10		1	3			5	7	3	1		3	20		3	3	4	5
Phoridae	1		4			13		1	3	3	13	1								
Otitidae		3		1		1				1									1	3
Tephritidae			3	1		2														
Agromyzidae	3					1		2			1						1			
Lauxaniidae						1				3	1						1	3		
Chamaemyiidae		1															2			
Drosophilidae			2																	
Ephydridae											1					1			1	
Chloropidae	2		14		28	3			1	2	3	2		1	18		3	3	2	6
Scathophagidae																				
Anthomyzidae																				
Muscidae										4						1	3	3	2	
Tachinidae										1										
Platypezidae																				
Syrphidae																				
Curtonotidae																				
Tabanidae																				
Lonchaeidae																				
Asteiidae																				
Milichiidae																	1			
Scatopsidae																				
Un-ID'ed	2	2	6	5		5		2	3	5	7	1	2	5	3	1	4	4	3	5
Araneae																				
Araneidae	1	4						3	1	1			1				1		1	
Linyphiidae				1		1		1			1						1			
Nesticidae	1																			
Dictynidae		2																		
Clubionidae				1																
Philodromidae				2		2		8			5	1		1			1		6	
Salticidae	1	1	5	3		5	1	6	1	3	2			1			4		3	4
Thomisidae						2											1			2
Oxyopidae		1							1											
Pisauridae				1				1												
Lycosidae							1	4									1			
Mimetidae	4																			
Hahniidae						1					3						3			
Miturgidae																				
Agelenidae																				
Un-ID'ed			1					1												
Collembola	1		8	1	2	13		2	3	3	1				1		2	2	3	
Odonata																				
Anisoptera																				
Zygoptera										1										
Orthoptera																				
Gryllidae																				
Caelifera	2	1	3	3	2	2	1		7	17	8	1		4	19		6		3	
Hemiptera																				
Aphididae		2	38		72	6		1	2	11	9	2		6	34		2	19	6	26
Hoppers	34	3	22	8	22	6		11	15	14	16			1	27		28	16		10
Tingidae	1		3	4		2								3				1		2
Berytidae			1	3		1									1					
Pentatomidae				3		1	1								1			1		
Lygaeidae	2	1	23	2	1	7		5	9			4		1	9		4		3	1
Rhopalidae																				
Miridae			2																	
Nabidae			1																	
Reduviidae								2												
Un-ID'ed		1																		
Thysanoptera	2	1	3		4	1		2	8	5	11	1	3	2	10		1	10	4	8

	Post burn Week 1																			
	Reference Sites				No Riparian Buffer							10 meter Riparian Buffer								
	ENTO		Sect 4 West		SW Past NE		NE Past		JY Middle			SW Past West			SW Past East			Wheatgrass		
Taxa	Grass	Trees	Grass	Shrubs	Grass	Trees	Grass	Trees	Grass	Trees	Shrubs	Grass	Trees	Shrubs	Grass	Trees	Shrubs	Grass	Trees	Shrubs
Psocoptera					1	8				1							1	1		
Coleoptera																				
Buprestidae												1								
Carabidae	3	2													1			1		2
Cantharidae				1						1	1									
Curculionidae	4	5	2		9				8	5		3		1	3			1	1	5
Chrysomelidae	5	2	8	10	2	3		5		2	6			3	4			4	1	3
Scolytidae												1								
Elateridae								1							1					
Mordellidae	1		4							2				1	3			1	1	
Staphylinidae																				
Lampyridae																				
Languriidae																				
Coccinellidae																				
Meloidae																				
Tenebrionidae																				
Nitidulidae																				
Haliplidae																				
Un-ID'ed																				
Neuroptera																				
Hemerobiidae																	1			
Myrmeleontidae															1					
Hymenoptera																				
Ichneumonoidea		4	3	2	4	5		5		7	2				8	1	3	4	1	2
Chalcidoidea	9	10	13	1	13	9	2	12	6	18	4	4	1	11	12	1	17	27	4	15
Formicidae	35	27	115	21	148	86	8	16	117	96	42	31	2	108	94	9	39	29	19	38
Apidae										1										
Un-ID'ed			1																	
Lepidoptera																				
Adults		1		1	1	3			1						3		1	1		2
Caterpillars	3			1	1	1			1	1					1					
Siphonaptera									1											
Acari																				
Mites	2		1	2	4	19		2	3						5		6		7	2
Opilliones						6										8	2			
Ixodidae																				
Ticks				1	1				1			1	1							
Isopoda						2														
Blattaria																				
Isoptera																				
Mantodea																				
Phasmantodea																				
Snails																				
Millipede																				
Un ID'ed	1		1	1		2		1		3		1		3				2		

	Post Burn Week 2																			
	Reference Sites				No Riparian Buffer							10 meter Riparian Buffer								
	ENTO		Sect 4 West		SW Past NE		NE Past		JY Middle			SW Past West			SW Past East			Wheatgrass		
Taxa	Grass	Trees	Grass	Shrubs	Grass	Trees	Grass	Trees	Grass	Trees	Shrubs	Grass	Trees	Shrubs	Grass	Trees	Shrubs	Grass	Trees	Shrubs
Diptera																				
Nematocera																				
Tipulidae						2			1				4			1	5		8	1
Bibionidae			1				2			1	3			2	11	1	5	2	6	
Sciaroidea	1	1	1	2						1					2				1	
Mycetophilidae			4											3	19	1	5	1	3	2
Sciaridae		13	14	7	1	1	2			1	2		1		32	3	9	3	12	11
Cecidomyiidae	3		19	2	3		1		3		10	4	3	1	12		1	2	33	20
Psychodidae				1				1			1		1						18	2
Chironomoidea	1		2	2					2		1				2		9	4		3
Ceratopogonidae	3		7	16	2	7			10	1	2		6	3	2	4	8	13	19	7
Chironomidae	1	1	18	4	2	6	2	7	10		5		6	7	12	2	15	45	18	17
Culicidae						1			1	1						1	4		3	4
Brachycera																				
Empididae										1									3	3
Dolichopodidae	2	5	27	1	1	4			2	1	5	1	12	4	18	4	11	22	16	8
Phoridae	2	1	2				1	3		1	1					1	2	1	3	3
Otitidae	1					1					3						3		4	5
Tephritidae																				2
Agromyzidae											7				3					
Lauxaniidae			1								19		1				1	2		2
Chamaemyiidae																				
Drosophilidae																				
Ephydridae											6							2		
Chloropidae	13	2	20	8	40	1	1		5	15	43	7	7	15	49		19	22	5	69
Scathophagidae										2										
Anthomyzidae																				
Muscidae			2	1		1		1	1	1	3						1	9	5	3
Tachinidae															1					
Platypezidae		1		1												1	1	2		
Syrphidae														2						
Curtonotidae		1								2										24
Tabanidae									1											
Lonchaeidae																				
Asteiidae																				
Milichiidae																				
Scatopsidae																				
Un-ID'ed	4		5	1	1	3	1			1	1	3		3	3		2	2	4	2
Araneae																				
Araneidae	1	1		1		2										1	1	2		2
Linyphiidae	6								1						1		1			
Nesticidae																				
Dictynidae	2									1					1					
Clubionidae		2															1			
Philodromidae					2			19		1	2		1	2					2	
Salticidae	2	3	3	7	5	4	3	7	1	4	2	3	3	8	6	1	2	3	6	6
Thomisidae	1		1			2	1	2				1	1	1			1		1	1
Oxyopidae	1																			
Pisauridae									1											
Lycosidae	1	3					3	2			1					2			1	2
Mimetidae	2	1				1			2											
Hahniidae	1								1											
Miturgidae																				
Agelenidae																				
Un-ID'ed		2										1		1			1		1	1
Collembola	9	1	19	2	5	1	1	1			2	7			1		3		1	
Odonata																				
Anisoptera																				
Zygoptera					1					2	1								4	
Orthoptera																				
Gryllidae																				
Caelifera	7	2	9	3	8	1	2		13	5	13	5	7	5	32	9	7	16	17	6
Hemiptera																				
Aphididae		1	47	1	191	10	3	6	3	5	19	15	5	41	63	1	2	20	45	62
Hoppers	63	18	64	11	47	9	6	16	17	17	30	58	34	13	64	7	64	37	12	24
Tingidae	5				1			3	1	7	1		1	1						3
Berytidae	2	4		32		2									2	1				
Pentatomidae														1	1					
Lygaeidae	5	3	31	10	6	4	2	5	2	4	3	14	4	1	9		7	6	2	1
Rhopalidae									4											
Miridae		1																		
Nabidae																				
Reduviidae					1				2											
Un-ID'ed				1																1
Thysanoptera	8	2	26	4	96	1	2	4	56	2	33	59	61	11	59	1	434	22	58	50

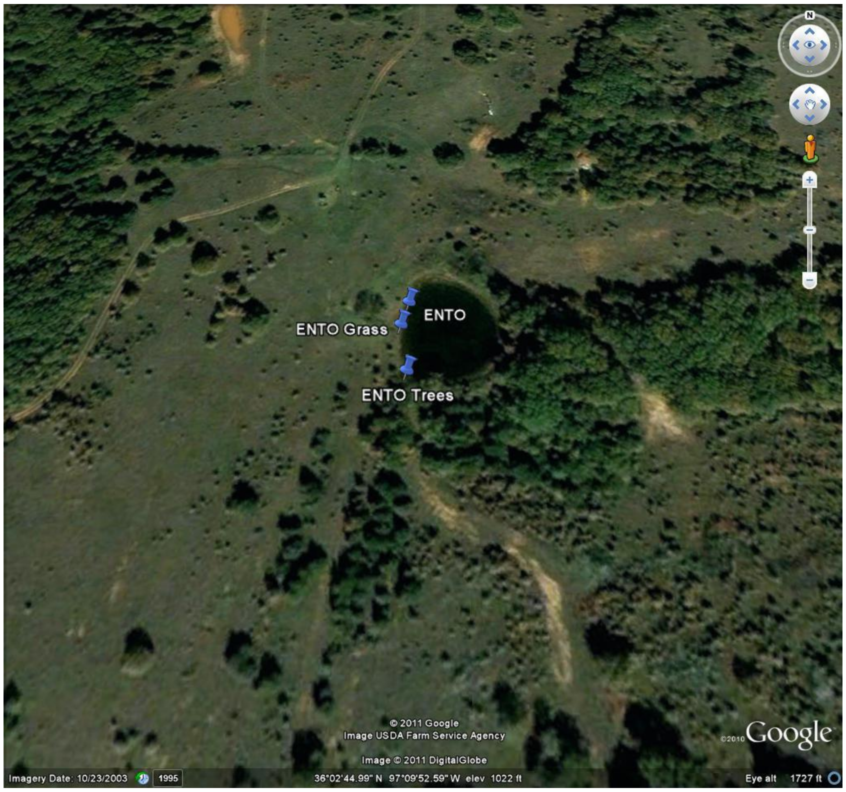
	Post Burn Week 2																			
	Reference Sites				No Riparian Buffer							10 meter Riparian Buffer								
	ENTO		Sect 4 West		SW Past NE		NE Past		JY Middle			SW Past West			SW Past East			Wheatgrass		
Taxa	Grass	Trees	Grass	Shrubs	Grass	Trees	Grass	Trees	Grass	Trees	Shrubs	Grass	Trees	Shrubs	Grass	Trees	Shrubs	Grass	Trees	Shrubs
Psocoptera			1			5			1			7				1	1			
Coleoptera																				
Buprestidae	4	1	1		2		1		1		1	1			1			1		
Carabidae	1			17	1	1	3					2		1	1		4		1	1
Cantharidae																				
Curculionidae	1	6	4		11	1	1		7		2	3		2	2		1	2	1	1
Chrysomelidae	28	1	8	7			3	2		1		10	4	3	9		2		2	3
Scolytidae																				
Elateridae			3													1		3		
Mordellidae	3		8	2	2						4	2		1	2				2	
Staphylinidae																			1	
Lampyridae					3	1													1	1
Languriidae																				
Coccinellidae																				
Meloidae																		2		
Tenebrionidae																				
Nitidulidae																				
Haliplidae																				
Un-ID'ed						2														
Neuroptera																				
Hemerobiidae					1						3									
Myrmeleontidae																		4		
Hymenoptera																				
Ichneumonoidea		1	6	3	4	4	1	5	1	2	7	1	1	7	17		6	4	3	12
Chalcidoidea	21	17	32	6	18	7	5	8	18	6	23	20	18	18	54	2	12	20	8	42
Formicidae	124	38	122	50	1382	31	24	19	235	70	182	268	18	152	180	27	74	148	35	51
Apidae									1		1								1	
Un-ID'ed																				
Lepidoptera																				
Adults	2		3	2	6	2				3	3		2	1	4	1	4			3
Caterpillars			8	2	4					2	4	3	4	1	4		1			
Siphonaptera																				
Acari																				
Mites	5	2	9	4	7	68	1		8	1		3	7	1	11	1	11		18	3
Opilliones											1		4			1				
Ixodidae																				
Ticks													4		2					
Isopoda						2	1												5	
Blattaria																2				
Isoptera																1				
Mantodea												7			1					1
Phasmantodea									1											
Snails							11		3			26								
Millipede																				
Un ID'ed	3		1	4	2			1			3	1	1		3		1		1	1

	Post Burn Week 3																			
	Reference Sites				No Riparian Buffer							10 meter Riparian Buffer								
	ENTO		Sect 4 West		SW Past NE		NE Past		JY Middle			SW Past West			SW Past East			Wheatgrass		
Taxa	Grass	Trees	Grass	Shrubs	Grass	Trees	Grass	Trees	Grass	Trees	Shrubs	Grass	Trees	Shrubs	Grass	Trees	Shrubs	Grass	Trees	Shrubs
Diptera																				
Nematocera																				
Tipulidae						3				1						2	2		1	
Bibionidae																1	5		3	
Sciaroidea							1													
Mycetophilidae	1		3			1	4				1	1				1	5			3
Sciaridae	3	17	11			1	4	1			2			1	2	1	4		23	7
Cecidomyiidae	2		11			1	5	3			9	1	2	3	10	4	2	1	10	9
Psychodidae						1	6				1					1			5	2
Chironomoidea	1		1				2	1												2
Ceratopogonidae			2	1		1	6	22		2	1	3			2	8	7	4	12	20
Chironomidae		1	15		1	3	12	7	3	2	4	2	4	8	7	13	6	6	59	54
Culicidae						1		3												
Brachycera																				
Empididae						1														
Dolichopodidae	1	3	13				12	2	2	3	1	1	3		13	2	6	3	10	
Phoridae	2	2	2					1									4		2	3
Otitidae	1	1				1											2		4	1
Tephritidae	1															1	1			
Agromyzidae								3			1			1			1		1	3
Lauxaniidae	1		4	1	22					1	34	1	1	2	35	1	7	1	1	2
Chamaemyiidae																				
Drosophilidae																				
Ephydridae																				
Chloropidae	8	8	3				13			5	27	5			5	1	14	1	1	18
Scathophagidae															1					
Anthomyzidae			1					1												1
Muscidae							2				3		1							2
Tachinidae		2																	1	1
Platypezidae								2								4			2	1
Syrphidae																				
Curtonotidae																				
Tabanidae																				
Lonchaeidae		1														1				
Asteiidae																2				
Milichiidae																				
Scatopsidae																				
Un-ID'ed	1	2		1		1		1	1							1	3	2	1	2
Araneae																				
Araneidae	2		2		1										1	2				
Linyphiidae		1	2				2					2	1	2	2	1	2			1
Nesticidae											3									
Dictynidae	2										1			1					1	1
Clubionidae		1																		
Philodromidae		2	1			15				1		1		2					2	2
Salticidae	5	1	7			5		2		2	3	3	2	4	1	1	8		1	8
Thomisidae			3			2	2	2				2	1			1				1
Oxyopidae					1					3										
Pisauridae																				1
Lycosidae	1	4			1											1				
Mimetidae	4				1															
Hahniidae		1																		
Miturgidae			1											1						
Agelenidae		4																		
Un-ID'ed											1				1		1			
Collembola	3		1			16								2					5	
Odonata																				
Anisoptera																1				
Zygoptera																				
Orthoptera																				
Gryllidae	4																			
Caelifera	3	3	6		13	2	3		4	5	1	5	6	16	34	3	11	2	5	1
Hemiptera																				
Aphididae	3	2	24	1	32	12	12		1	10	9	3	7	79	51	12	4	1	14	9
Hoppers	46	40	84	3	38	25	56	16	17	20	41	26	34	19	74	27	101	13	12	21
Tingidae						1			3	2		2	2			1	1		1	24
Berytidae		4		9							1				2					
Pentatomidae	1																			
Lygaeidae	7		25		7		1		13	4	3	5	1	3	25	3	12	2	5	5
Rhopalidae																				
Miridae															1					
Nabidae																				
Reduviidae										1					5					
Un-ID'ed									1											
Thysanoptera	4		13		17	3	3		6		14	34		24	31		1	2	51	8

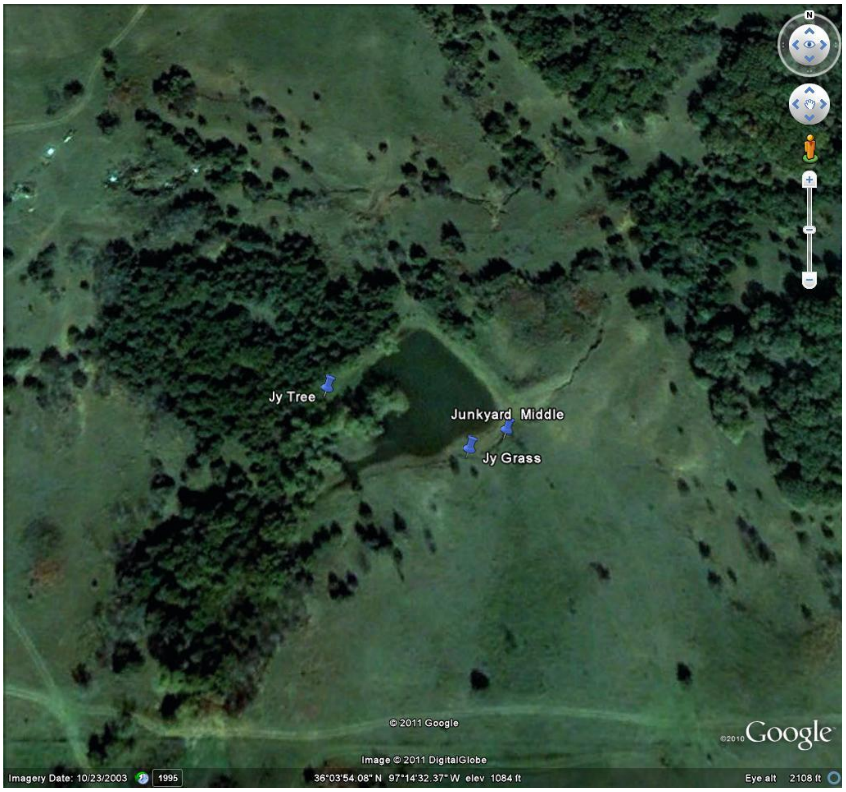
	Post Burn Week 3																			
	Reference Sites				No Riparian Buffer							10 meter Riparian Buffer								
	ENTO		Sect 4 West		SW Past NE		NE Past		JY Middle			SW Past West			SW Past East			Wheatgrass		
Taxa	Grass	Trees	Grass	Shrubs	Grass	Trees	Grass	Trees	Grass	Trees	Shrubs	Grass	Trees	Shrubs	Grass	Trees	Shrubs	Grass	Trees	Shrubs
Psocoptera			1								1	1				2	1			1
Coleoptera																				
Buprestidae					5				1	1		4			1	1				1
Carabidae	1	2	2	3		2			1		3	2		1	1		2	1		
Cantharidae																				
Curculionidae	4	8			7		7		8	1		5	1		3	2	1	3	2	3
Chrysomelidae	3		1		2	10	7		1				1	1	6				5	2
Scolytidae																				
Elateridae														1				1	1	
Mordellidae	2										2	1		2	6			1		1
Staphylinidae		1													1					1
Lampyridae							1		1				1				2			
Languriidae						1														
Coccinellidae					1		1	1												
Meloidae			1					1			2									
Tenebrionidae					1															
Nitidulidae																				
Haliplidae																				
Un-ID'ed	1		1		1															
Neuroptera																				
Hemerobiidae											5								3	
Myrmeleontidae					2					1										
Hymenoptera																				
Ichneumonoidea	3	1				3	2				4	2	3		13	5	2	2	1	10
Chalcidoidea	2	13	35		7	18	6	1		7	15	4	7	10	25	3	2	7	18	33
Formicidae	127	71	35	2	548	66	161	28	136	108	165	163	68	138	312	36	74	9	43	33
Apidae			3											1						3
Un-ID'ed												1								
Lepidoptera																				
Adults	1					4	2	3	1	2			1	5	3	11	3	1		1
Caterpillars		1			2		1	1	2		1				4			1	2	1
Siphonaptera																				
Acari																				
Mites	1				1	36	1		4		6	1	1		6		1	1	7	
Opilliones								3					1			1	2			
Ixodidae																				
Ticks																			1	
Isopoda																1				
Blattaria	1																			
Isoptera																				
Mantodea															2					
Phasmantodea	1														1					
Snails								6	1		1	1	1			2			2	
Millipede																				
Un ID'ed	1					1	1	1							1	2		2		

	Post Burn Week 4																			
	Reference Sites				No Riparian Buffer							10 meter Riparian Buffer								
	ENTO		Sect 4 West		SW Past NE		NE Past		JY Middle			SW Past West			SW Past East			Wheatgrass		
Taxa	Grass	Trees	Grass	Shrubs	Grass	Trees	Grass	Trees	Grass	Trees	Shrubs	Grass	Trees	Shrubs	Grass	Trees	Shrubs	Grass	Trees	Shrubs
Diptera																				
Nematocera																				
Tipulidae								3					2							
Bibionidae								1												
Sciaroidea																				
Mycetophilidae								1											1	
Sciaridae			1	2				3											2	
Cecidomyiidae	1		3					5											1	1
Psychodidae																				
Chironomoidea					1	1		2									1	1		2
Ceratopogonidae			5	1			1	5			1					3		5	4	9
Chironomidae			9	1			2	14		1		1	1	3			1	1	3	11
Culicidae		1						2						1					1	
Brachycera																				
Empididae																				
Dolichopodidae	5	2	5	1		5		4			2			2			2		5	2
Phoridae																				
Otitidae													1							
Tephritidae								1											1	
Agromyzidae								2								1	2			
Lauxaniidae				1		1		3									2		1	1
Chamaemyiidae													1							
Drosophilidae						1											1		7	
Ephydridae					2								1					2		
Chloropidae		2	4	1				5			1		1	2			3		7	2
Scathophagidae																			2	
Anthomyzidae				1									12	1						
Muscidae									1											
Tachinidae		1																		
Platypezidae											1									
Syrphidae																				
Curtonotidae																				
Tabanidae																				
Lonchaeidae		3								1			1	2						
Asteiidae																				
Milichiidae																				
Scatopsidae																				
Un-ID'ed		1	2	2	2			2	2	2	2						1		1	2
Araneae																				
Araneidae	2	2	2	2			1	4		3	1		1							
Linyphiidae	1																			1
Nesticidae																				
Dictynidae													1							
Clubionidae			1																	
Philodromidae		2					1	6	1	1				1						
Salticidae	6	2	1	1			1	3		4	1	1	1	3	1		1	2	6	
Thomisidae			1			1	1					1							1	1
Oxyopidae																				
Pisauridae																			1	
Lycosidae				1						1					1					1
Mimetidae																				
Hahniidae																				
Miturgidae																				
Agelenidae																				
Un-ID'ed			1											1				2	2	
Collembola	1																			1
Odonata																				
Anisoptera																		1		1
Zygoptera									1	2			2							
Orthoptera																				
Gryllidae																				
Caelifera	2	1	2	1	2	1	1	2	2	1		5	3	7	5	1	6	4	3	1
Hemiptera																				
Aphididae	1	3	15	5	4	1		5			2	3	1		3		2	3	3	3
Hoppers	61	13	51	17	13	14	3	32	8	11	19	19	12	17	9	9	56	29	16	16
Tingidae			1	3				1		2	1		1	6		1	1			1
Berytidae		3	2	20						1	1	1			1					
Pentatomidae				1										1			1			
Lygaeidae	7		21	6	2					2	4	2	3	3	3	1	4	7	5	3
Rhopalidae															1					
Miridae				1											1					
Nabidae																				
Reduviidae				1																
Un-ID'ed				1			1							1						
Thysanoptera	5	1	7					8	2		1	2	2	2		1			1	1

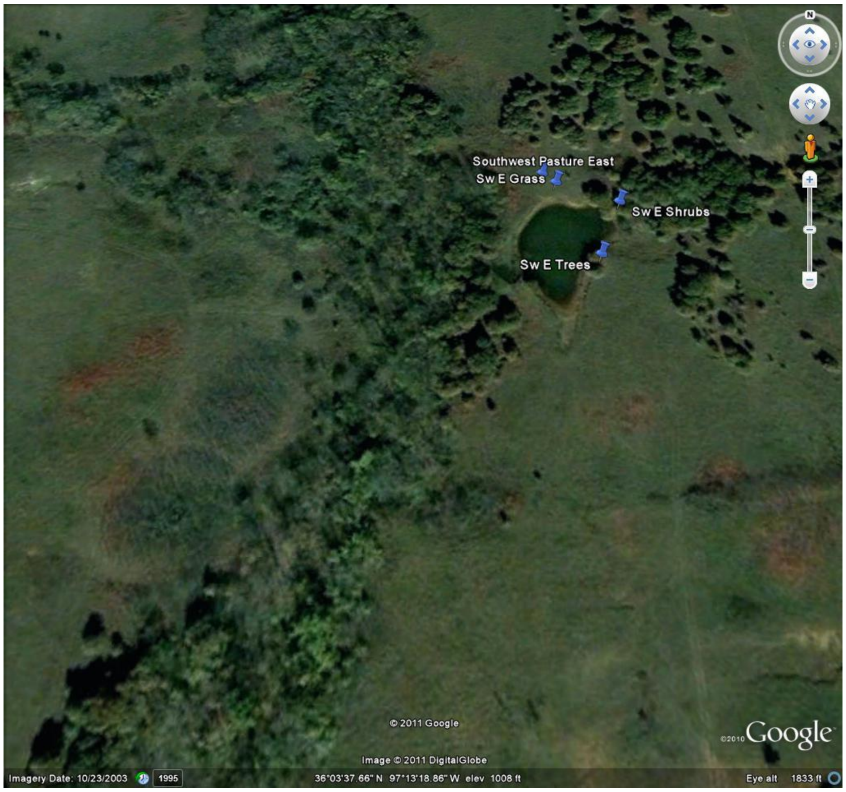
	Post Burn Week 4																			
	Reference Sites				No Riparian Buffer							10 meter Riparian Buffer								
	ENTO		Sect 4 West		SW Past NE		NE Past		JY Middle			SW Past West			SW Past East			Wheatgrass		
Taxa	Grass	Trees	Grass	Shrubs	Grass	Trees	Grass	Trees	Grass	Trees	Shrubs	Grass	Trees	Shrubs	Grass	Trees	Shrubs	Grass	Trees	Shrubs
Psocoptera		1		1											1					
Coleoptera																				
Buprestidae					2						1	1		1		1	1			1
Carabidae	1	2			2				4				1				1		2	1
Cantharidae													1							
Curculionidae		11	2		5		1		5	2	1	2	1	1					2	4
Chrysomelidae		1	3	21	2		1			1	2	3	3	4	9		2		1	3
Scolytidae																				
Elateridae	2					1				1							1		1	
Mordellidae	2			4			1				1			1	1					
Staphylinidae			1	4																
Lampyridae								1								1				2
Languriidae																				
Coccinellidae				1		1		1									1			
Meloidae		2				1		1												4
Tenebrionidae															2					
Nitidulidae															3					
Haliplidae					1															
Un-ID'ed					1					1					1					
Neuroptera																				
Hemerobiidae								1												
Myrmeleontidae																		1		
Hymenoptera																				
Ichneumonoidea	1		1	1	1			1		1	4	1	2						1	
Chalcidoidea	4	3	9	2				13	1		1		5	1				1	12	2
Formicidae	249	26	84	9	80	19	17	87	7	6	17	48	8	66	14	10	3	12	5	2
Apidae	2		3		1							1	1	1			2			
Un-ID'ed																				
Lepidoptera																				
Adults	3		2	2				1				1	1							
Caterpillars			1	1		3		1			1				1				2	
Siphonaptera																				
Acari																				
Mites				1				2					2							1
Opilliones		2														1				
Ixodidae																				
Ticks				1																1
Isopoda							8	1					1						7	
Blattaria		1																		
Isoptera																				
Mantodea																				2
Phasmantodea		1																		1
Snails									2	1		6		1	2		1			
Millipede		1															1			
Un ID'ed		1					1	1				1			2				2	1


ENTO
ENTO Grass
ENTO Trees
© 2011 Google
Image USDA Farm Service Agency
Image © 2011 DigitalGlobe
Imagery Date: 10/23/2003
1995
36°02'44.99" N 97°09'52.59" W elev 1022 ft
Eye alt 1727 ft
Google


Section 4 West
S4 Shrubs
S4 Grass
© 2011 Google
Image © 2011 DigitalGlobe
Imagery Date: 10/23/2003
1995
36°03'40.53" N 97°12'27.57" W elev 1020 ft
Eye alt 1849 ft
Google

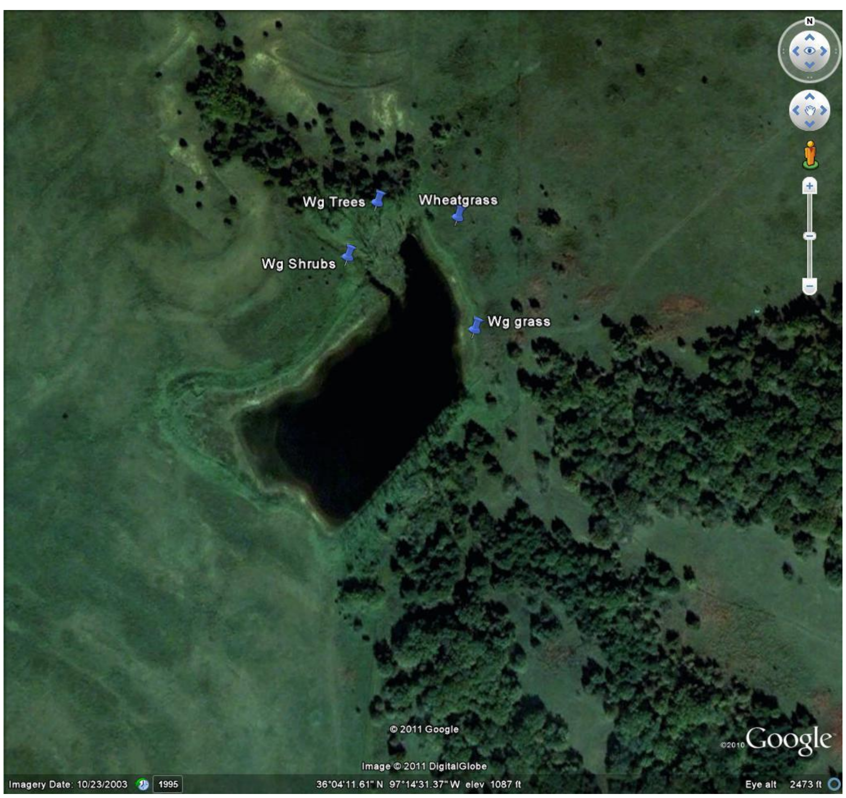

Jy Tree
Junkyard Middle
Jy Grass
© 2011 Google
Image © 2011 DigitalGlobe
Imagery Date: 10/23/2003
1995
36°03'54.08" N 97°14'32.37" W elev 1084 ft
Eye alt 2108 ft
Google


Ne Grass
Northeast Pasture
Ne Trees
© 2011 Google
Image © 2011 DigitalGlobe
Imagery Date: 10/23/2003
1995
36°04'01.11" N 97°12'59.71" W elev 1073 ft
Eye alt 1790 ft
Google


Southwest Pasture East
Sw E Grass
Sw E Shrubs
Sw E Trees
© 2011 Google
Image © 2011 DigitalGlobe
Imagery Date: 10/23/2003
1995
36°03'37.66" N 97°13'18.86" W elev 1008 ft
Eye alt 1833 ft
©2010 Google


Sw Ne Grass
Southwest Pasture Northeast
Sw Ne Trees
© 2011 Google
Image © 2011 DigitalGlobe
Imagery Date: 10/23/2003
1995
36°03'47.17" N 97°13'16.85" W elev 1022 ft
Eye alt 1833 ft
©2010 Google


Southwest Pasture West
Sw Grass
Sw Trees
Sw Shrubs
© 2011 Google
Image © 2011 DigitalGlobe
Imagery Date: 10/23/2003
1995
36°03'43.80" N 97°13'31.13" W elev 1041 ft
Eye alt 2111 ft


Wg Trees
Wheatgrass
Wg Shrubs
Wg grass
© 2011 Google
Image © 2011 DigitalGlobe
Imagery Date: 10/23/2003
1995
36°04'11.61" N 97°14'31.37" W elev 1087 ft
Eye alt 2473 ft

VITA

Warren Hanson

Candidate for the Degree of

Master of Science

Thesis: IMPACT OF WATERSHED BURNING AND GRAZING ON RIPARIAN ARTHROPOD COMMUNITIES ALONG PONDS ON THE OKLAHOMA STATE UNIVERSITY RESEARCH RANGE

Major Field: Environmental Science

Biographical:

Education:

Completed the requirements for the Master of Science in Environmental Science at Oklahoma State University, Stillwater, Oklahoma in May, 2011.

Completed the requirements for the Bachelor of Science in Marine Biology at Southwestern College, Winfield, KS in 2006.

Experience:

Assistant Scientist, Fort Environmental Laboratories, Inc., Stillwater, OK *February 2007-February 2011*

Bacon, J., D. Fort, R. Rogers, and W. Hanson. When Pollutants and Predators Co-exist: Distinguishing Between Malformations and Selective Predation in Newly-metamorphosed *Bufo marinus* in Bermuda. SETAC North America 2010 Annual Meeting. November 2010 (Poster Presentation).

Fort, D., W. Hanson, R. Rogers, and J. Bacon. Pond Sediment from Bermuda Alters Reproduction and Endocrine Function in Fathead Minnows (*Pimephales promelas*) and Killifish (*Fundulus heteroclitis*). SETAC North America 2010 Annual Meeting. November 2010 (Poster Presentation).

Hanson, W. and C. Greenwood. Impacts of burning and grazing on riparian arthropod communities along ponds on the Oklahoma State University Research Range. Entomological Society of America Southwestern Branch 2009 Annual Meeting (Poster Presentation).

Fort, D.J., R.L. Rogers, M. Benyshek, W. Hanson, S. Mornhinweg, A. Benyshek, P.D. Guiney, and J.A. Weeks. Effect of Polybrominated Diphenylethers on Anuran Metamorphosis and the Thyroid Axis. *Aquatic Toxicol*ogy, in press.

Professional Memberships:

Entomological Society of America Southwestern Branch 2009 - 2010

Tri-Beta National Biological Honors Society 2006 – 2011 *Delta Chapter Secretary May 2006*

Name: Warren Hanson Date of Degree: May, 2011

Institution: Oklahoma State University Location: Stillwater, Oklahoma

Title of Study: IMPACT OF WATERSHED BURNING AND GRAZING ON RIPARIAN ARTHROPOD COMMUNITIES ALONG PONDS ON THE OKLAHOMA STATE UNIVERSITY RESEARCH RANGE

Pages in Study: 93 Candidate for the Degree of Master of Science

Major Field: Environmental Science

Scope and Method of Study: Food webs in aquatic and terrestrial ecosystems have been subject to frequent studies, but interactions between these systems are not well understood. Energy flow between both aquatic and terrestrial systems establishes a complex food web that influences both systems. Riparian arthropods play an important role in the energy transfer between systems. This study evaluated the effects of range management practices on the riparian arthropod community within a cross timbers ecoregion. Following a controlled burn, with and without a vegetative buffer, changes in riparian arthropod communities were observed. Eight ponds (2 reference, 3 no buffer, 3 10m buffer) on the OSURR had samples taken from three habitat types (grass, trees, shrubs) prior to the burn, and weekly thereafter.

Findings and Conclusions: Arthropod abundance at reference ponds increased over time. By the third week post-burn, both shrub and grass habitats at treatment ponds had higher mean arthropod abundance than reference ponds. Abundance values at treatment ponds peaked and then returned to near pre-burn levels, below values seen at reference ponds. Diversity indices indicated few significant differences. Shannon-Wiener increased initially, but leveled off by week four. Taxa evenness decreased initially, but by week four, treatment ponds had a higher evenness than reference ponds. Taxa richness values generally responded quickly, with constant responses throughout the treatment and reference ponds. Diptera were more abundant at the 10 m buffer treatment, with values significantly higher than no buffer treatment ponds at week two. Brachycera and Nematocera displayed similar results when separately analyzed. Araneae did not respond quickly; lower abundance values were observed throughout the study. At week three, a significantly higher mean abundance at reference ponds was observed. Auchenorrhyncha were lower in abundance for both treatments throughout than at reference ponds. Despite this, weeks two and four resulted in a significantly higher abundance at reference ponds. Coleoptera at treatment ponds were also found to have a delayed recovery, with low abundance values noted until week three. Overall, this study indicates that taxa specific responses occur following a rangeland burn. Some flying taxa (Diptera) responded quickly, while some predators (Coleoptera, Aranaeae) responded slowly. By the end of the study, it was presumed that the riparian system had begun to recover, with values returning to near pre-burn values. However, seasonal data would be necessary to establish a better picture of the recovery of the riparian arthropod community.

ADVISER'S APPROVAL: Carmen M. Greenwood