LRTF Research Funding Request for Summer 2012

Impact of a Roadside Prairie Planting on Plant and Insect Communities

Dr. Kirk J. Larsen, Principle Investigator
Department of Biology, Luther College, Decorah, IA 52101
563-387-1558, larsenkj@luther.edu

Introduction

Roadside prairie plantings and prairie restorations provide a number of environmental and economic benefits. These benefits include erosion control, weed control, improved aesthetics, reduced maintenance costs, and re-establish a native ecosystem that allows connection to our regional natural history (Landers 1970, Egan & Harrington 1990). Creating and restoring diverse native ecosystems also increases habitat for wildlife. Although plant diversity is higher in remnant prairies and prairie restorations than in prairie plantings (Shepherd & Debinski 2005), many of the benefits of diverse native prairie ecosystems are created by prairie plantings.

In Iowa, where agriculture now dominates the landscape, providing native habitat for natural enemies may reduce pest control costs and increase pollinators which may improve yields. For example, ground beetles (Coleoptera: Carabidae) are significant biological control agents in corn and soybean fields. Vegetatively complex roadside prairie plantings host more diverse ground beetle assemblages than "simple" roadsides dominated by smooth brome, *Bromus inermis* (Varchola & Dunn 1999). Roadside prairie plantings have also been shown to host more diverse bee communities than weedy roadsides, increasing pollinators on the landscape (Hopwood 2008). Even in suburban landscapes, it has been shown that landscaping with native vegetation results in significantly greater abundance and species richness of butterflies than landscaping with non-native vegetation (Burghardt *et al.* 2008).

Other insects, such as butterflies, have also benefited from the presence of diverse native roadsides. Planting roadside prairie near prairie remnants significantly increased the abundance of habitat-sensitive (i.e. prairie specialist) butterflies, but evidently does not affect the abundance of disturbance-tolerant butterflies (Ries *et al.* 2001) that may already exist in weedy roadsides. One concern with planting roadside prairie as habitat for butterflies is the potential to increase road-kill mortality of butterflies, which can be significant (McKenna et al. 2001). However, roadside prairie plantings compensate for that loss by increasing the overall abundance of butterflies (Shepherd & Debinski 2005). Mowing roadsides has also been shown to negatively affect butterfly communities by directly destroying eggs and larvae, and indirectly by reducing the abundance of nectar and larval food plant resources (Johst *et al.* 2006). For that reason, a shift to a native prairie plantings requiring less mowing is desirable.

The US-52 Roadside Planting Project

In October 2008, the Iowa DOT began roadside prairie establishment in the right-of-way (ROW) of US-52 from the Decorah city limits (Winneshiek County) north to the Minnesota state line using Smith Seeding of Eldridge, Iowa as contractors. The timing and proximity of this IDOT

project to the Luther campus (site of the Gateway Prairie planting, Projects 90-00-LRTF-512 & 90-00-LRTF-610) has created a unique opportunity to study the impact of this roadside prairie planting on the plant and insect communities inhabiting this roadside area before, during, and after the establishment of this planting. One of the main criticisms of most studies on the effect of prairie management or plantings on plant and insect communities is the lack of baseline, pretreatment data. This particular study does contain baseline data as monitoring for vegetation and insects began before the IDOT project commenced and untreated control plots continue.

Butterflies have been monitored previously in Iowa roadsides by Ries *et al.* (2001) and Shepherd & Debinski (2005). Ground beetles are known to be excellent indicators of habitat disturbance and change (Evans 1983, Eyre *et al.* 1989). As both butterfly and ground beetle communities of the Decorah area are well known (Larsen & Bovee 2002, Larsen *et al.* 2003), we are using butterflies (Lepidoptera) and ground beetles (Coleoptera: Carabidae) as indicators of general impacts of this roadside prairie establishment on herbivore and predator insect groups.

During the summer of 2008, Luther College established 9 monitoring sites (3 "control", 3 "organic" and 3 "spray" sites) and began baseline monitoring of plant, ground beetle and butterfly communities in the US-52 roadside. Untreated "control" sites are located outside the planting project area along US-52 south of Decorah. The "spray" sites are areas that were planted using the standard roadside planting protocol including mowing, spraying with herbicides, and disking. The "organic" sites are located in a 2 mile long area of the project where an adjacent organic farmer has requested IDOT not use herbicides and use mowing and disking only during the planting and establishment phase.

Our goal is to monitor changes to both plant and insect roadside communities over a 5-year period as this project progresses: to obtain baseline data during 2008 (Project 90-00-LRTF-800), initial establishment during 2009 (Project 90-00-LRTF-910) and 2010 (Project 90-00-LRTF-013) after the spraying and planting during heavy weed management (primarily by mowing), during 2011 (Project 90-00-LRTF-106) which is to be the first year without mowing, and then additional follow up as the planting becomes more established in 2012 (this proposal). We hypothesize that as this diverse native prairie roadside planting becomes established, there will be increased plant species richness and plant productivity, along with increased insect abundance and insect species richness.

The specific objectives of the proposed project in 2012 will be to study the impact of this roadside planting on plant species richness, above-ground plant productivity, butterfly abundance and species richness, and ground beetle abundance and species richness. As in previous years, one Luther College undergraduate biology student will work as a research assistant with Dr. Larsen during the summer (full time) and fall (part time) of 2012. We are requesting $11,186.37 to Luther College to complete this 5-year study in 2012 to follow up the baseline sampling and sampling that began in 2008.

Research Methodology

Research Locations. In conjunction with IDOT personnel (Ole Skaar), we established nine research monitoring sites (Table 1) in the ROW along US-52 and Iowa Hwy 9 from approx 3 miles south of Decorah to 5 miles north of Decorah (Figure 1). There are three replicate sites for

each of the following treatments: "control" sites outside of the roadside planting area (south of Decorah along US-52), three sites in an area near organic farms that will have a special "organic" planting protocol that does not use herbicides, and three "spray" sites planted with the standard IDOT roadside planting protocol including the use of mowing, disking, and herbicides during establishment and for weed treatment. At each of the nine monitoring sites, a 100-m long transect has been established and located using GPS, and south end of each transect marked with a sign located along the fence line at the edge of the ROW (Figure 2). This transect is located half way between the fence line and the edge of the highway shoulder. All plant and insect monitoring occurs along these transects once a month in June, July, August, and September each year. Digital photographs of each transect site (taken from the south end of each site) are taken for annual comparisons several times each summer (Figure 3).

Plant Diversity and Productivity. Plant diversity is recorded at each site during early-June, mid-July, and late-August. We identify and record each species of plant found along each transect and collect voucher specimens for each species. Percent cover is calculated with four subsamples taken at randomized locations along each transect. At each subsample, plants (or bare ground or litter) below 25 points in a 0.25 m^2 grid are identified. Additional plant species observed within 2 m of each transect are assigned one "contact point" in the nearest percent cover subsample. The cumulative species list is used to determine plant species richness at each site. These species are identified as native or non-native (as determined by BONAP 2011), and categorized to functional group (forb, grass, woody, litter, or bare ground).

To measure above-ground plant productivity, at the end of the growing season in early September, all standing plants are clipped and surface litter removed from four random 0.25 m^2 quadrat locations along the transect at each site, dried at 55°C in a drying oven, and weighed to determine biomass (in g/m^2) for grasses, forbs, and surface litter.

Butterfly Monitoring. At each site, butterfly surveys involve walking the 100 m transect at each site at a slow steady pace during both a morning and an afternoon visit once each month (eight visits total: June through September), counting and identifying all butterflies observed. This survey method is similar to techniques used in roadsides by Ries *et al.* (2001) and Shepherd & Debinski (2005). The order sites are surveyed, and scheduling of morning and afternoon visits are randomized each month. To ensure good flight activity, all surveys must occur between 1000 and 1500 h CDT at temperatures between 24°C (75°F) and 35°C (95°F), with wind speeds less than 24 kph (15 mph). Cloud coverage must be less than 90% (i.e., some blue sky is visible). Weather conditions, time spent walking the transect, and numbers of each species of butterfly seen in a 5 m wide band in front of the observers are recorded.

Any butterflies not identified "on the wing" are collected in a butterfly net, identified and released, or stored in a glassine butterfly envelopes and returned to the laboratory for identification and vouchering. Butterflies are identified using Hendrix and Debinski (2003), Schlict *et al.* (2007) and Opler *et al.* (2009). Voucher specimens for each species are housed in the research insect collection of the Hoslett Museum of Natural History at Luther College.

Ground Beetle Sampling. Ground beetles are collected using pitfall traps during four 7-day periods, once each month from June through September. Each pitfall trap is constructed from one 473 mL (16 oz) plastic cup (9 cm dia) placed into the ground so the lip of the cup is at or

slightly below the ground surface. In each cup is placed approximately 50 mL of propylene glycol preservative diluted at a 1:1 ratio with water. A funnel constructed from a 207 mL casual cup insert prevents beetle escape. Four traps are placed at 10 m intervals along the transect at each site.

Following processing and mounting of the samples, all ground beetles are identified to species using keys presented in Lindroth (1961-1969) and Noonan (1991). Names are standardized using Bousquet & Larochelle (1993). Species richness and beetle abundance (beetles/trap/day) are calculated for each treatment. Voucher specimens are housed in the reference insect collection in the Hoslett Museum of Natural History, Luther College, Decorah, Iowa.

Data Analysis. For each of the three treatments, plant, butterfly, and beetle species assemblages are summarized in terms of overall abundance, species richness, diversity (H'), and evenness (J'). The diversity and evenness values are calculated using *Ecological Analysis* software with log base 2 (Eckblad 1998). All data are tested for normality. For normally distributed data, ANOVA tests are used to compare treatment effects, while non-parametric Kruskal-Wallace tests are used to compare treatment effects for non-normally distributed data (PASW 2010).

IDOT Permit Required. An "Application to Perform Work within State Highway Right-of-Way" was submitted and permit approved by the local IDOT office (Kathie Rustad, 2305 US Highway 52 South, Decorah) for this monitoring work to proceed. A copy of this permit that expires 15 October 2012 is attached to this proposal.

Results from Previous Work

Plant Diversity and Productivity. From 2008-2010, a total of 50 species of plants have been identified in the roadside of US-52 at these 9 sites (Table 2). Of these, only 4 are species that have been planted as part of the roadside planting. The greatest average plant species richness has been found in the control sites (Figure 4). Although with the cessation of mowing in 2011, establishment of the native forbs and grasses is expected to shift this dramatically.

Percent cover indicates non-native grasses currently dominate the roadsides (Figure 5), although there has been a significant shift from bare ground in 2008 to litter in 2009, primarily due to the frequent mowing that occurred in 2009 and 2010 following the seeding.

There was a significant reduction in overall net primary productivity (g/m^2) of vegetation from 2008 (Figure 6) to 2009 (Figure 7) and 2010 (Figure 8) due to the mowing of the organic and sprayed plots during the plant establishment phase in 2009-2010. Mowing of the organic and spray treatments significantly reduced grass net primary productivity in 2009 which also decreased litter accumulation (Figure 7), while some additional mowing in the control area in 2010 reduced overall productivity there (Figure 8).

Butterfly Survey Results. A total of 1,737 butterflies representing 31 species (Table 3) have been observed at these 9 sites along US-52 from 2008 to 2010. These are relatively low numbers given the number of surveys performed, but considering the small roadside strips between corn or soybean fields and the highway and lack of native forbs to date these numbers are to be expected. With the frequent mowing of organic and spray treatments in 2009, there were fewer

butterflies collected (Figure 9). In 2010, there was a dramatic increase in butterfly abundance in the unmowed control as well as treatment sites (Figure 10). Because of the increased butterfly abundance in the control sites, is likely the higher abundance and species richness of butterflies in 2010 in organic and spray sites were due to an exceptionally good year for butterflies rather than any treatment effects.

Ground Beetle Survey Results. Overall, 2,416 carabids representing 56 species of ground beetles (Table 4) have been collected from the roadside of US-52 in 2008-2010. Overall species richness has decreased since 2008 in all but the spray plots (Figure 11).

Overall beetle abundance (beetles/trap/day) was greater in 2010 than previous years in both organic and spray treatments (Figure 12) which may indicate some treatment effects. As this diverse roadside prairie planting becomes established and mowing ceases, increased ground beetle abundance and species richness is expected.

Budget Request for 2012 Work

Direct Costs:	
Principle Investigator salary	$3251.28
Benefits (PI FICA @7.65%)	$248.72
Student hourly	$1250.00
Summer Student Stipend	$3500.00
Benefits (summer student FICA @7.65%)	$267.75
Summer Housing on campus (10 weeks @$12)	$840.00
Travel (mileage to sites, presentations at meetings)	$500.00
Supplies and Equipment	$500.00
Total Direct Costs	$10,357.75
Indirect Costs (8%)	$828.62
Total Request for 2012	**$11,186.37**

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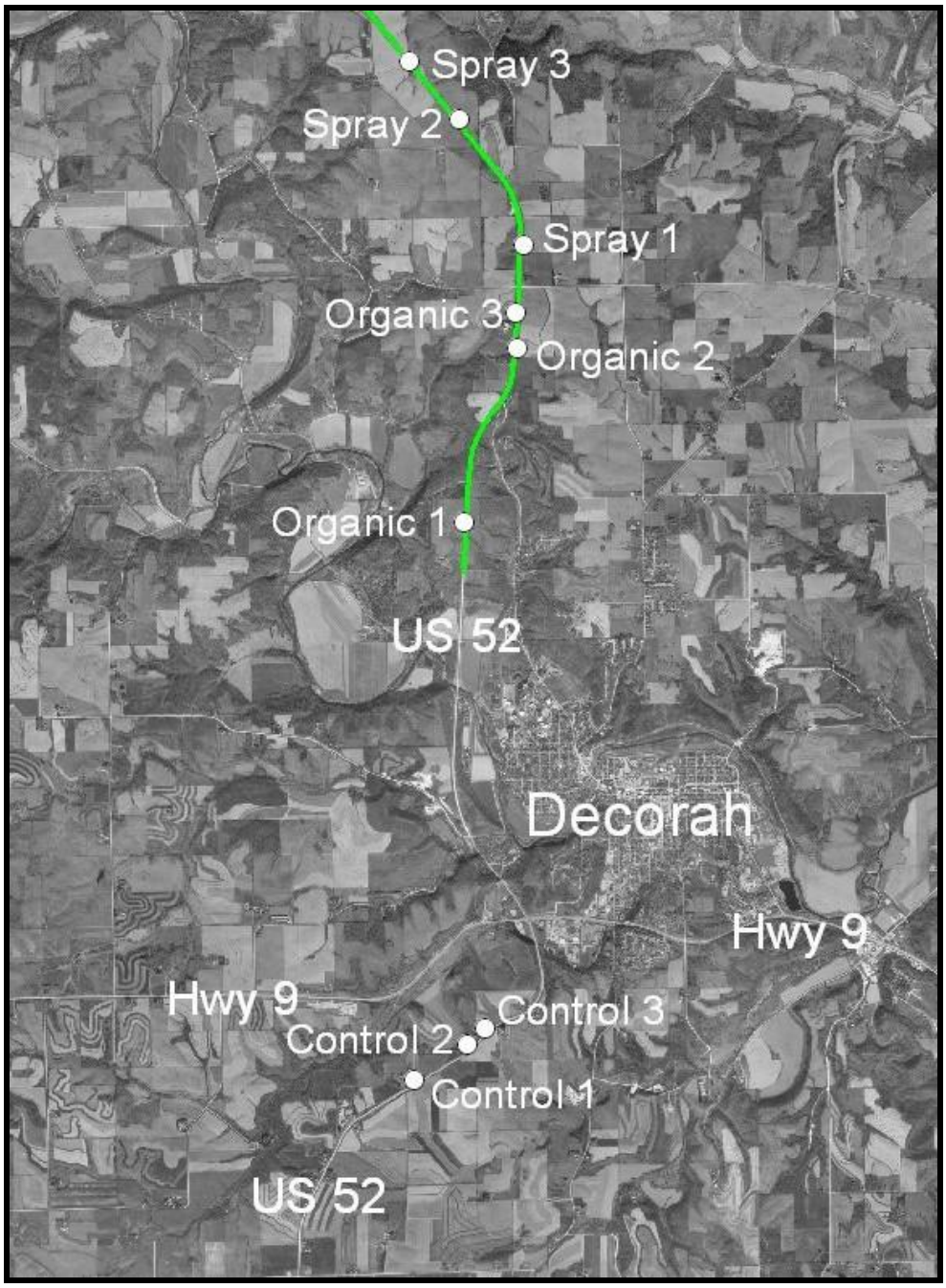

Figure 1. Location of nine biodiversity monitoring sites along US-52 in Winneshiek County, with area of US-52 roadside planting project highlighted in green.

Figure 2. Sign posted along fence at south end of each monitoring site along US-52.

Figure 3. North view of the "Spray 2" site transect on the east side of US-52 in June 2010.

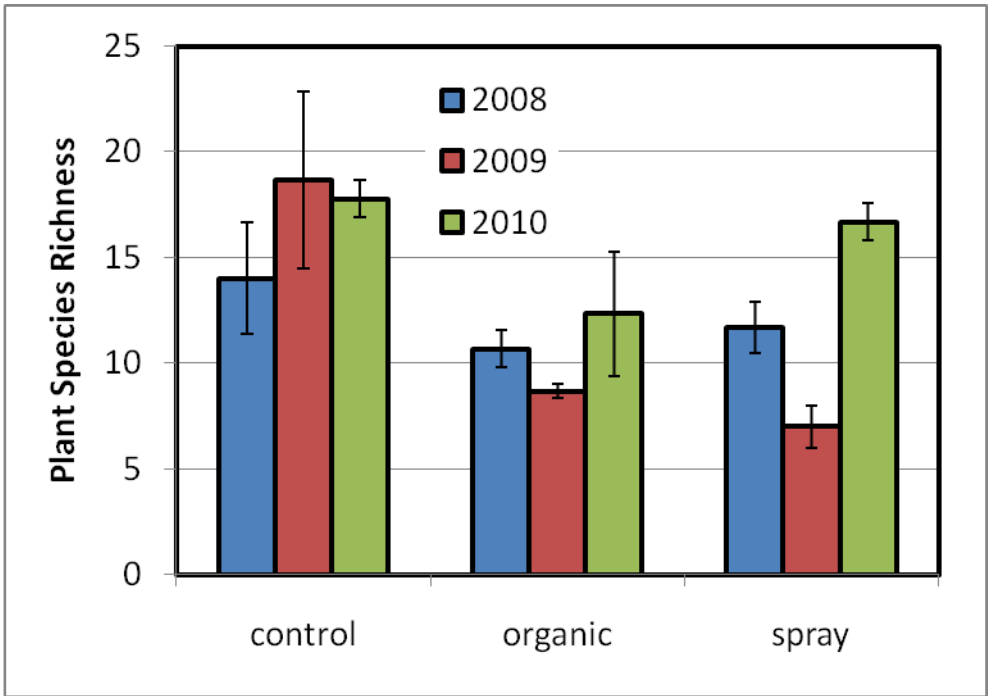

Figure 4. Average (± SE) plant species richness in the three treatments along US-52 during 2008 (baseline) and 2009 and 2010 (planting establishment).

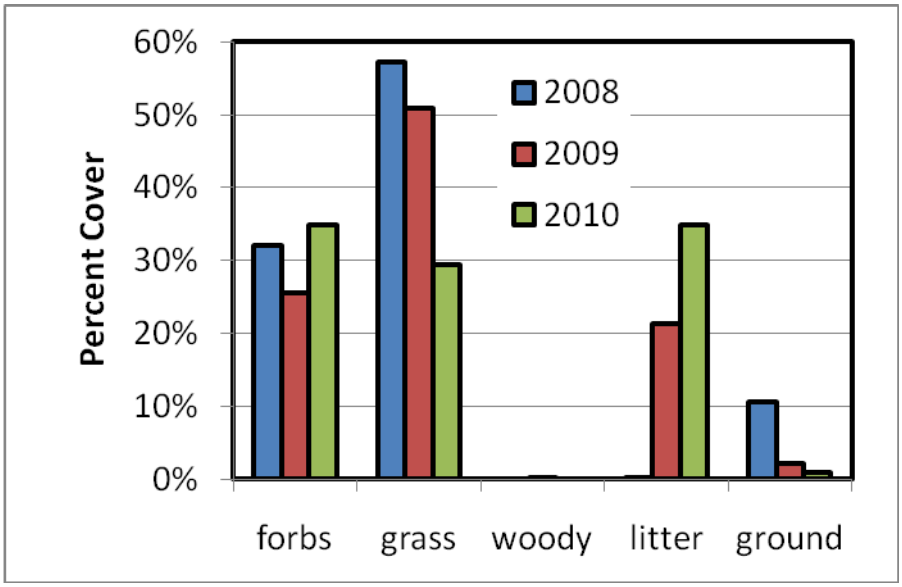

Figure 5. Total percent cover by plant functional groups along US-52 during 2008 (baseline) and 2009 and 2010 (planting establishment).

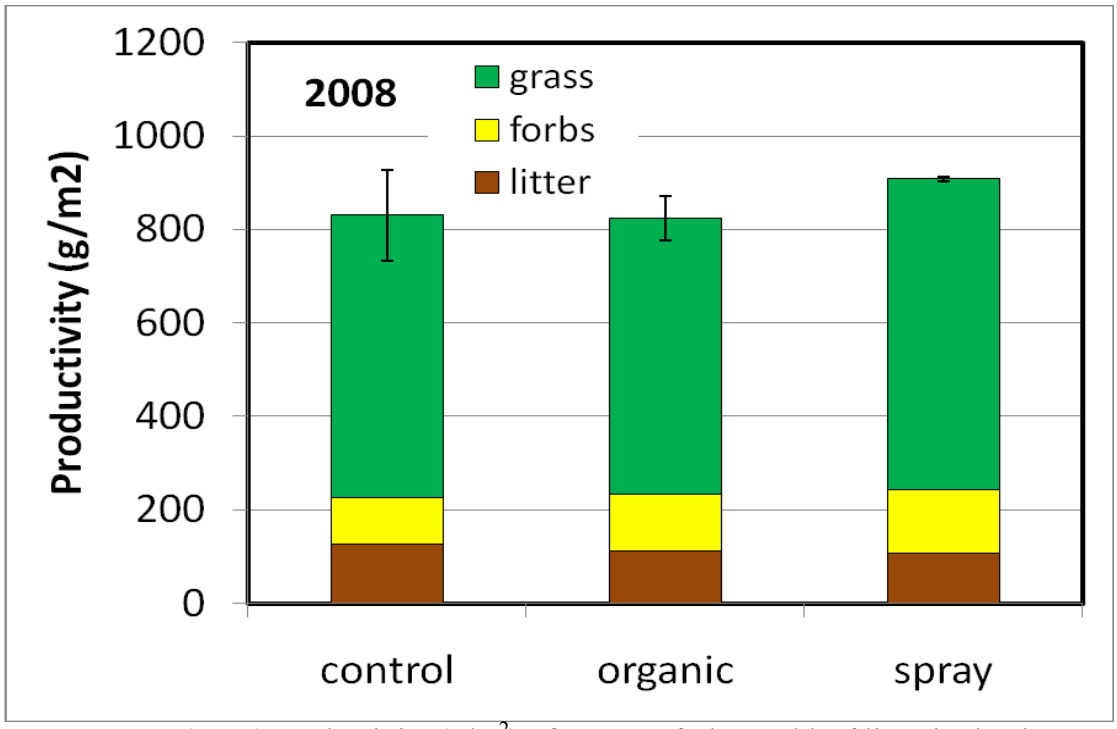

Figure 6. Average (± SE) productivity (g/m^2) of grasses, forbs, and leaf litter in the three treatments along US-52 during 2008 (baseline).

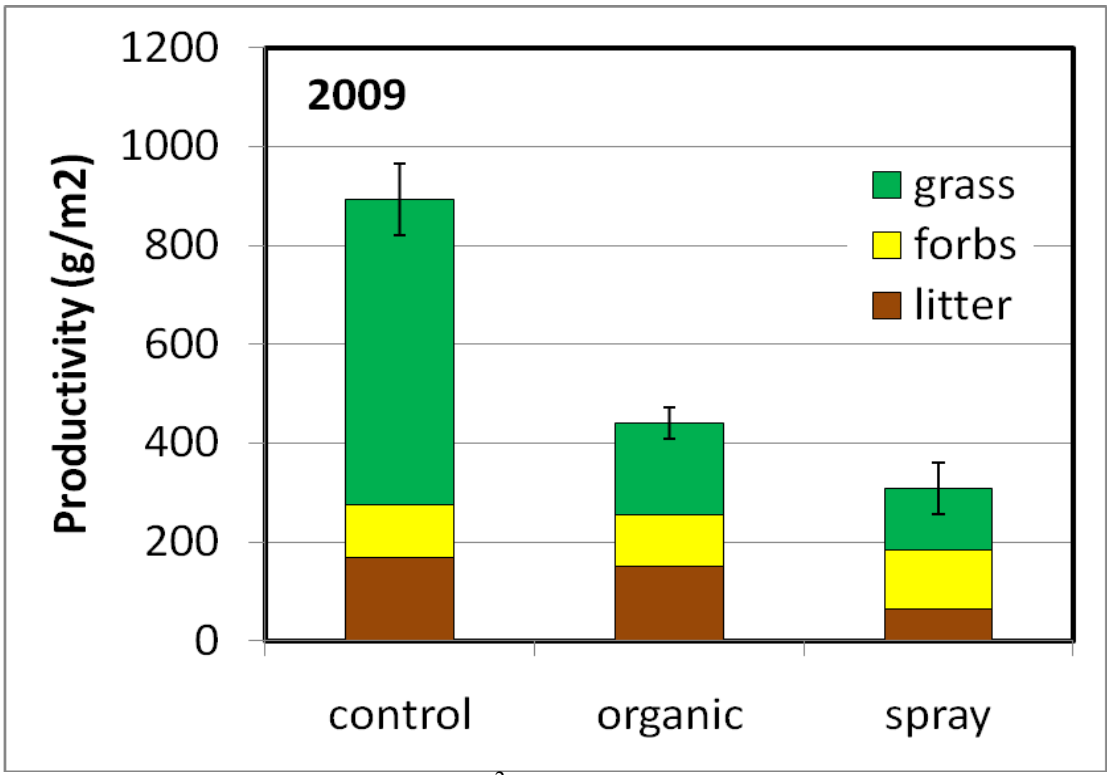

Figure 7. Average (± SE) productivity (g/m^2) of grasses, forbs, and leaf litter in the three treatments along US-52 during 2009 (first year of planting establishment).

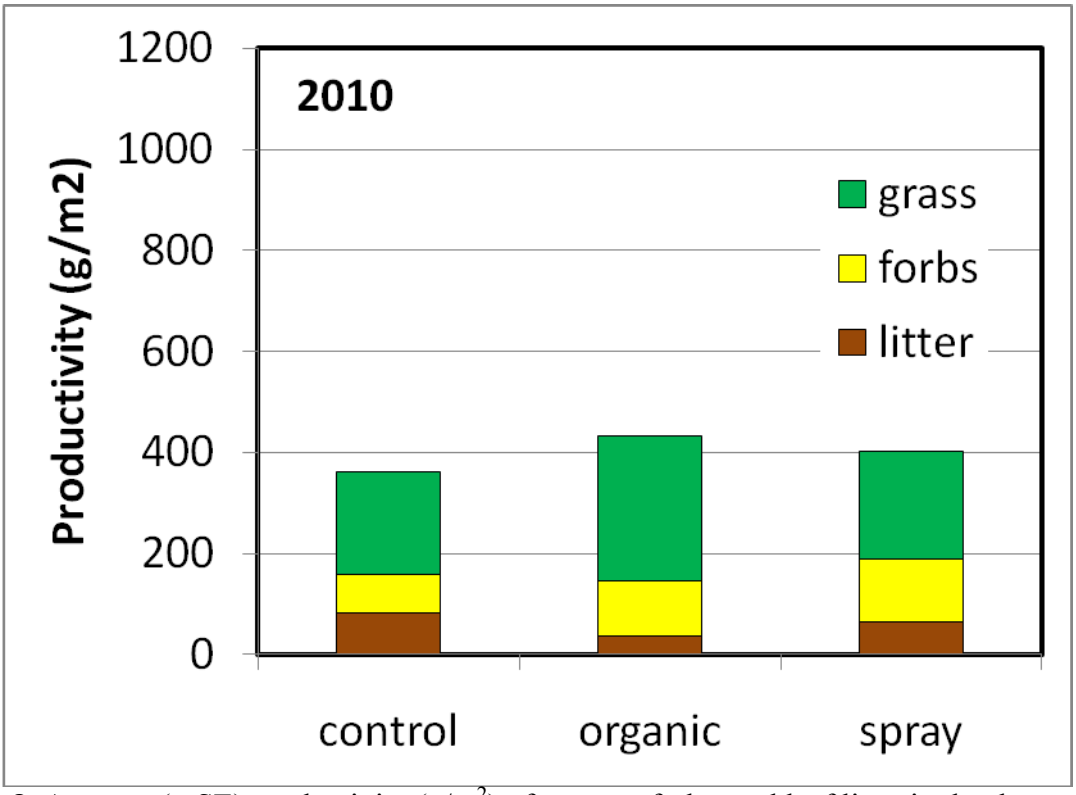

Figure 8. Average (± SE) productivity (g/m^2) of grasses, forbs, and leaf litter in the three treatments along US-52 during 2010 (second year of planting establishment).

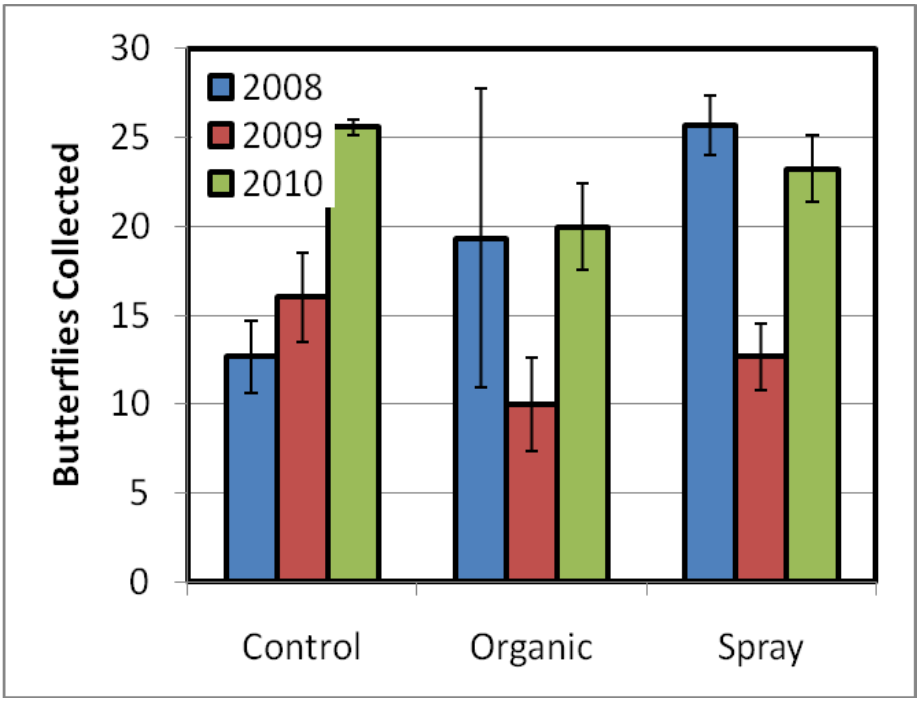

Figure 9. Average (± SE) total number of butterflies observed in the three treatments along US-52 during 2008 (baseline) and 2009 and 2010 (planting establishment).

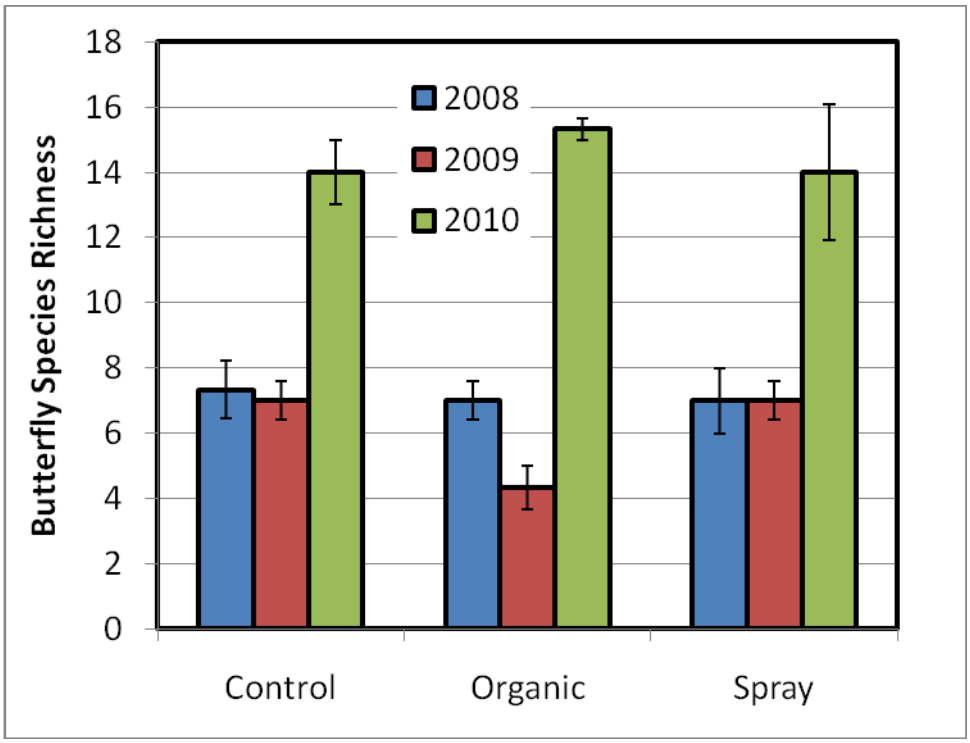

Figure 10. Average (± SE) butterfly species richness observed in the three treatments along US-52 during 2008 (baseline) and 2009 (planting establishment).

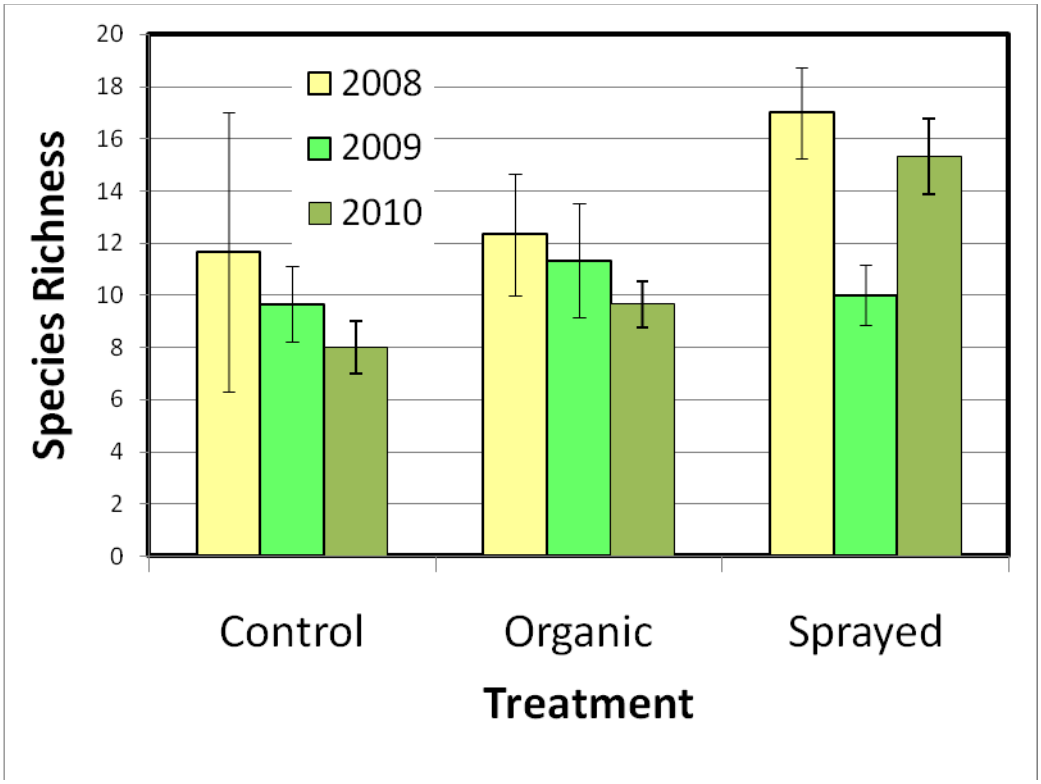

Figure 11. Average (± SE) ground beetle species richness in the three treatments along US-52 during 2008 (baseline) and 2009 and 2010 (planting establishment).

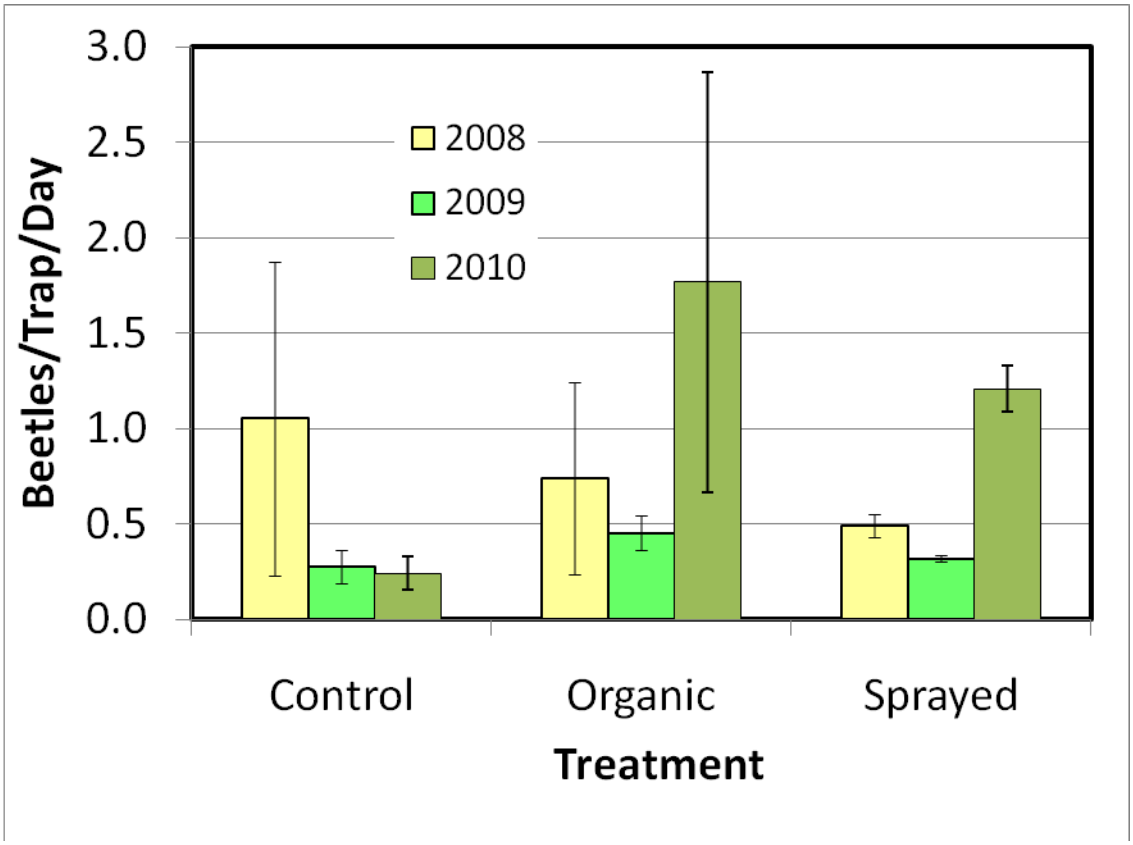

Figure 12. Average (± SE) relative ground beetle abundance (beetles/trap/day) in the three treatments along US-52 during 2008 (baseline) and 2009 and 2010 (planting establishment).

Table 1. Locality information for nine biodiversity monitoring sites established along US-52 near Decorah, Iowa.

Site Name	Code	US-52 Station and side	Geographic Coordinates
Control 1	C1	1260, East ROW	43°16.355'N, 91°49.580'W
Control 2	C2	1275, West ROW	43°16.506'N, 91°49.268'W
Control 3	C3	1290, West ROW	43°16.623'N, 91°48.971'W
Organic 1	O1	255-260, West ROW	43°19.943'N, 91°48.770'W
Organic 2	O2	325-330, East ROW	43°21.026'N, 91°48.303'W
Organic 3	O3	340, West ROW	43°21.240'N, 91°48.309'W
Spray 1	S1	365-370, East ROW	43°21.665'N, 91°48.241'W
Spray 2	S2	420, East ROW	43°22.449'N, 91°48.767'W
Spray 3	S3	455, West TOW	43°22.810'N, 91°49.187'W

Table 2. Plant species identified in the US-52 roadside sites from 2008-2010.

Scientific Name	Common Name	fxnl group	status	seeded?
Ambrosia trifida	Giant Ragweed	forb	invasive	N
Asclepias syriaca	Common Milkweed	forb	native	N
Bromus inermus	Smooth Brome	grass	invasive	N
Chenopodium album	common lambsquarter	forb	native	N
Cichorium intybus	Chickory	forb	invasive	N
Cirsium altissimum	Tall Thistle	forb	native	N
Cirsium arvense	Canada Thistle	forb	invasive	N
Cirsium arvense	Prairie Thistle	forb	invasive	N
Convolvulus hastata	Field Bindweed/Morning Glory	forb	invasive	N
Conyza canadensis	Horseweed	forb	invasive	N
Cornus florida	Dogwood	woody	invasive	N
Daucus carota	Wild Carrot/Queen Anne's Lace	forb	invasive	N
Elymus repens	Quackgrass	grass	invasive	N
Equiscetum arvense	Field Horsetail	forb	native	N
Erigeron annuus	Fleabane	forb	native	N
Festuca rubra	Red Fescue	grass	invasive	N
Hordeum jubatum	Foxtail Barley	grass	invasive	N
Juglans nigra	Black Walnut	woody	invasive	N
Juniperus virginiana	Red Cedar	woody	invasive	N
Linaria vulgaris	Butter and Eggs	forb	invasive	N
Lonicera sp.	Honeysuckle	woody	invasive	N
Lotus corniculatus	Birdsfoot Tick Trefoil	forb	native	N
Medicago sativa	Alfalfa	forb	invasive	N
Melitotus sp.	Sweet Clover	forb	invasive	N
Monarda fistulosa	**Wild Bergamot/Bee Balm**	**forb**	**native**	**Y**
Onopordum acanthium	Scotch Thistle	forb	invasive	N
Parthenocissus quinquefolia	Virginia Creeper	forb	invasive	N
Pastinaca sativa	Wild Parsnip	forb	invasive	N
Penstemon digitalis	**Foxglove Beardtongue**	**forb**	**native**	**Y**
Phalaris arundinacaea	Reed Canary Grass	grass	invasive	N
Physalis sp.	Wild Ground Cherry	forb	native	N
Poa compressa	Canadian Bluegrass	grass	invasive	N
Poa pratensis	Kentucky Bluegrass	grass	invasive	N
Prunus serotina	Black Cherry	woody	invasive	N
Rubus occidentalis	Black Raspberry	forb	native	N
Rudbeckia hirta	**Black-Eyed Susan**	**forb**	**native**	**Y**
Rumex sp.	Dock	forb	invasive	N
Sambucus canadensis	Elderberry	forb	invasive	N
Schedonorous phoenix	Tall Fescue	grass	invasive	N
Securigera varia	Crown Vetch	forb	invasive	N
Solidago canadensis	Canada Goldenrod	forb	native	N
Symphyotrichum puniceum	Purplestem	forb	unknown	N
Taraxacum officinale	Dandelion	forb	native	N
Trifolium hybridum	Alsike Clover	forb	invasive	N
Trifolium pratense	Red Clover	forb	invasive	N
Ulmus spp.	Elm	woody	invasive	N
Verbascum thapsus	Common Mullein	forb	invasive	N
Verbena hastata	**Blue Vervain**	**forb**	**native**	**Y**

Vicia americana	American Vetch	forb	native	N
Vitis riparia	Wild Grape	forb	invasive	N

Table 3. Species list of butterflies observed in the transects along US-52 from 2008-2010.

Species	Common Name
Anatrytone logan	Delaware Skipper
Ancyloxypha numitor	Least Skipper
Asterocampa celtis	Hackberry Emperor
Boloria bellona	Meadow Fritillary
Celastrina ladon	Spring Azure
Celastrina neglecta	Summer Azure
Ceryonis pegala	Common Wood Nymph
Colias cesonia	Southern Dogface
Colias eurytheme	Orange Sulphur
Colias philodice	Clouded Sulphur
Danaus plexippus	Monarch
Epargyreus clarus	Silver-Spotted Skipper
Eurema lisa	Little Sulphur
Everes comyntas	Eastern Tailed-Blue
Junonia coenia	Buckeye
Libytheana carinenta	American Snout
Limenitis archippus	Viceroy
Limenitis arthemis astyanax	Red-Spotted Purple
Lycaena dione	Gray Copper
Lycaena hyllus	Bronze Copper
Megisto cymela	Little Wood Satyr
Nymphalis antiopa	Mourning Cloak
Papilio glaucus	Eastern Tiger Swallowtail
Papilio polyxenes	Black Swallowtail
Phyciodes tharos	Pearl Crescent
Pieris rapae	Cabbage White
Speyeria aphrodite	Aphrodite Fritillary
Speyeria cybele	Great Spangled Fritillary
Vanessa atalanta	Red Admiral
Vanessa cardui	Painted Lady
Vanessa virginiensis	American Lady

Table 4. List of scientific names of the 56 species of ground beetles collected from the US-52 roadside at 9 sites from 2008-2010.

Acupalpus partiarius	*Dicaelus elongatus*
Agonum cupripenne	*Dicaelus purpuratus*
Agonum fidele	*Dicaelus sculptilis*
Agonum gratiosum	*Diplocheila obtusa*
Agonum palustre	*Dyschirius globulosus*
Agonum placidum	*Elaphropus sp.*
Amara aeneopolita	*Elaphrus sp.*
Amara angustata	*Galerita janus*
Amara patruelis	*Harpalus compar*
Amphasia sericea	*Harpalus erythropus*
Anisodactylus harrisii	*Harpalus herbivagus*
Anisodactylus ovularis	*Harpalus pensylvanicus*
Anisodactylus rusticus	*Harpalus somnulentus*
Badister notatus	*Loricera pilicornis*
Bembidion praticola	*Olisthopus parmatus*
Bembidion quadrimaculatum oppositum	*Ophonus puncticeps*
Bembidion rapidum	*Oxypselaphus pusillus*
Bembidion versicolor	*Poecilus chalcites*
Bradycellus rupestris	*Poecilus lucublandus*
Calathus gregarius	*Pterostichus commutabilis*
Chlaenius emarginatus	*Pterostichus femoralis*
Chlaenius platyderus	*Pterostichus melanarius*
Chlaenius purpuricollis	*Pterostichus permundus*
Chlaenius pusillus	*Pterostichus stygicus*
Chlaenius tricolor	*Scarites quadriceps*
Cicindela sexguttata	*Sphaeroderus stenostomus lecontei*
Cyclotrachelus seximpressus	*Stenolophus conjunctus*
Cyclotrachelus sodalis	*Synuchus impunctatus*