Final Report for

A Pilot Study to Investigate the Impacts of Emerging Warm- Season Grass Management Systems on Wildlife Habitat Components

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Background

The increased interest in biomass energy has resulted in unprecedented potential for the establishment of grasslands in the eastern US. There are several grassland systems presently under consideration as viable biomass energy crops including warm season grass monocultures (e.g., *Panicum virgatum*, or switchgrass), exotic species (e.g., *Miscanthus* or elephant grass), or mixed native warm season grasses such as A*ndropogon girardii* (big bluestem), *Schizachyriam scoparium* (little bluestem), and *Sorgastrum nutans* (indiangrass).

The value of mixed native warm season grasses (NWSG) for wildlife is well documented, and forms the basis for multiple federal programs that promote wildlife habitat establishment. Recent research t has focused on avifauna in native and managed NWSG grass stands (Juliano and Daves 2006; Fletcher and Koford 2002; Delisle and Savidge 1997). In addition to wildlife habitat, other work has suggested that native warm season grasses planted as a biomass crop offer ecological benefits such as carbon sequestration, nutrient cycling, and erosion buffering (Fletcher *et al.* 2010, Tillman *et al.* 2006).

Little work has been done on the potential impacts of differing grassland management practices on wildlife habitat quality, particularly in stands managed for biomass. Potential impacts to wildlife habitat quality are likely to occur with different harvest practices, NWSG planting density, field configuration, and other stand management activities (e.g., burning, disking, fertilization, etc.). In Virginia, there are 2 likely harvest scenarios. The first is a dual crop system where NWSG stands are harvested during the growing season (typically in July) to provide forage hay, then harvested again after the growing season for biomass. The second is a biomass system where producers would only harvest NWSG stands after the growing season and represents management that would occur on lands used solely for biomass production.

Aside from the direct impacts of the harvesting, little is known about the potential impact these practices will have on habitat quality. However, a comprehensive evaluation of habitat quality was beyond the short-term (4 month) scope of this project, so we elected to focus on biomass management practices and their potential impact on food availability. Specifically, we chose to examine the availability of insect prey and/or seeds at periods during and after the growing season as an index habitat quality.

We hypothesized that the food availability in a harvested stand would be lower compared to an unharvested NWSG stand. Further, we hypothesize that food availability between dual-harvest and biomass harvest systems will also differ.

Our pilot project attempted to identify potential impacts to wildlife habitat value by measuring food availability between NWSG stands under 3 different biomass management regimes. Our objective was to determine the differences in available food items during the summer and fall between NWSG stands managed for biomass, and to compare the strengths and weaknesses of the different methods available for assessing insect abundance and diversity in these stands.

Methods

We tested our hypotheses by initiating a non-replicated pilot experiment within a single 1.5 ha (3.6 acre) stand of mature NWSG in southwest Virginia (Figure 1). This stand was established as a mix of switchgrass, big bluestem, and indiangrass in 2000. At the time of this study, the field was largely comprised of switchgrass with little other NWSG and some small patches of other species such as *Rubus* spp. We assumed that the composition, structure, and density of NWSG in this stand are consistent with fields planting specifically for biomass.

We divided the field into 3 areas of approximately equal size and randomly assigned a management treatment; dual crop (i.e., harvest in August and in December), biomass crop (i.e. harvest in December only), and control (i.e., no harvest). With each treatment we established a 25 m transect in the middle of each section for the placement of insect and seed traps. Insect and seed traps were placed at 5 m intervals along each transect (Figure 1). At each trapping station we employed 3 traps to collect both insects and seeds. We elected to deploy 2 different trap sets in order to capture a range of invertebrates and seeds with a secondary objective to determine which traps provide the single best option for capturing invertebrates and seeds. These traps included 2 yellow plastic "sticky traps" (10 cm x 25.5cm: Horti-kure™ Aerocure® International Inc.) (Copeland 2004). We placed one horizontal sticky trap on a wire frame approximately 2.5 cm from the ground, and another attached vertically to a wire pin flag approximately 0.5 m from the ground. We also installed a single pitfall trap constructed from 2 nested 9.5 cm diameter- 16oz plastic Solo™ beverage cups (Solo Cup Company®, Lake Forest, IL) buried so the tops were flush with the ground. Pitfall traps were filled with a supersaturated salt solution to act as a killing agent and preservative and a small amount of dish soap to decrease surface tension.

We applied treatments immediately before our sampling activities. We were unable to harvest the entire section as originally planned due to complications with available equipment and hay contractors, so we were forced to manually harvest the immediate areas around the transect only. All NWSG material within 3 m of the transect was cut to a height of 20 cm with an electric trimmer powered by a portable gasoline generator, and removed from the site to simulate harvest.

We operated each trapping array 3 times for 3 consecutive days from August 6-9, October 28-31, and December 1-4 2009 for each treatment. During each sampling period traps were checked each day to ensure proper operation. At the end of the sampling period the traps were removed and their contents stored for

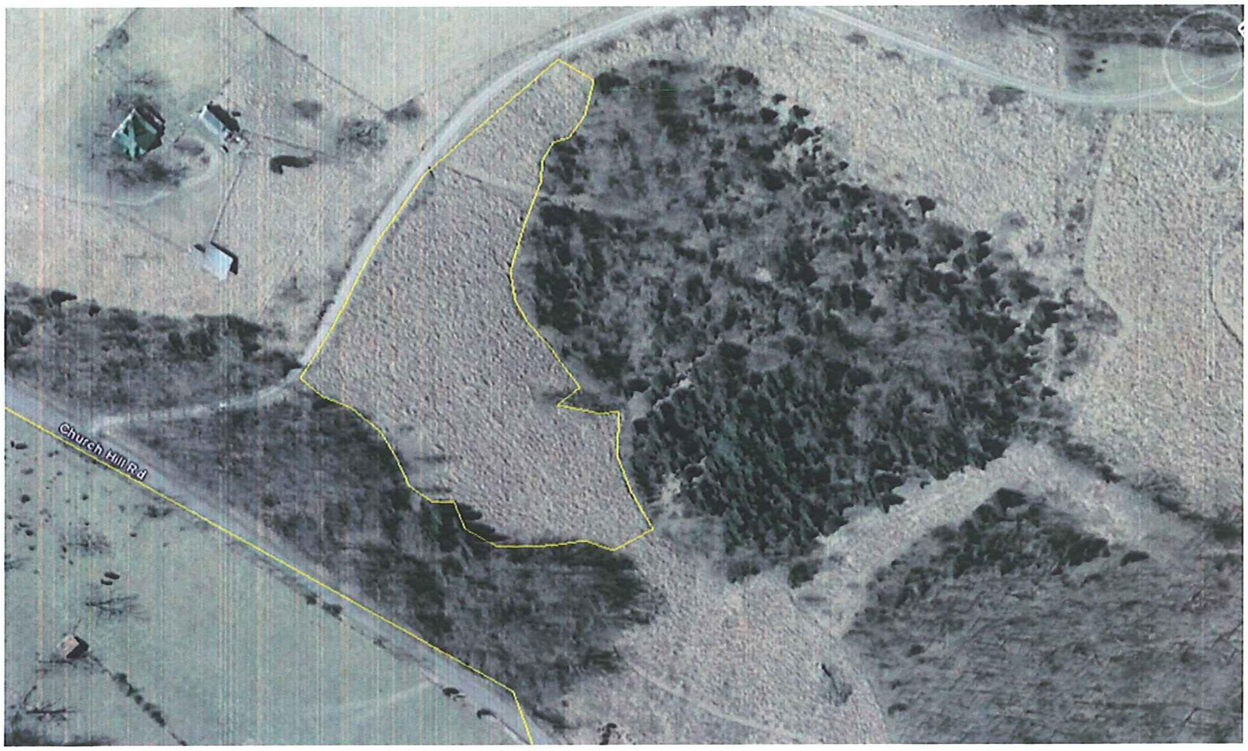

Figure 1. Aerial photograph (spring season) of the warm season grass fields used for this project. All transects were located within the area enclosed by the yellow polygon.

analysis. Both horizontal and vertical sticky traps were wrapped in plastic wrap and tagged with transect, station, and date information, and stored in a freezer. The contents of the pitfall traps were rinsed with alcohol, combined into a single sample jar for each transect and sampling bout, and preserved with 95% ethyl alcohol for analysis.

We completed analysis of all invertebrate and seed captured in the lab after all sampling was completed. Invertebrates from all three trapping methods were identified to order and classified by size (<2mm, 2-5mm, 5-10mm, and >10mm). Seeds were counted and classified to species where possible.

Results

Invertebrates

This project was designed to be a non-replicated experiment therefore we present the observed non transformed data without performing univariate statistical analysis. . We summed both the insect and seed data to determine a total abundance value for each treatment and period over the season for each trapping method (Figures 2 a-c).

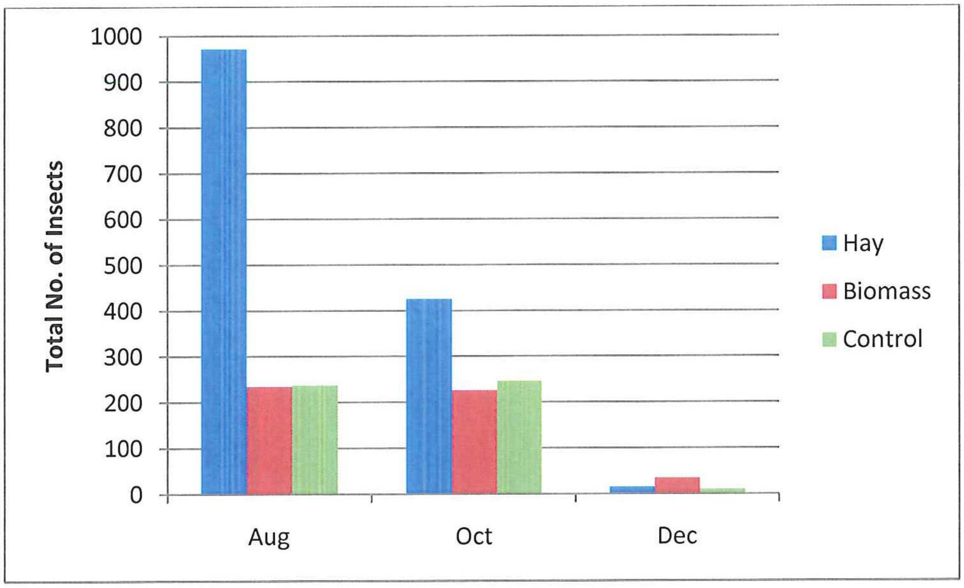

Figure 2a. Total number of invertebrates captured by horizontal sticky traps.

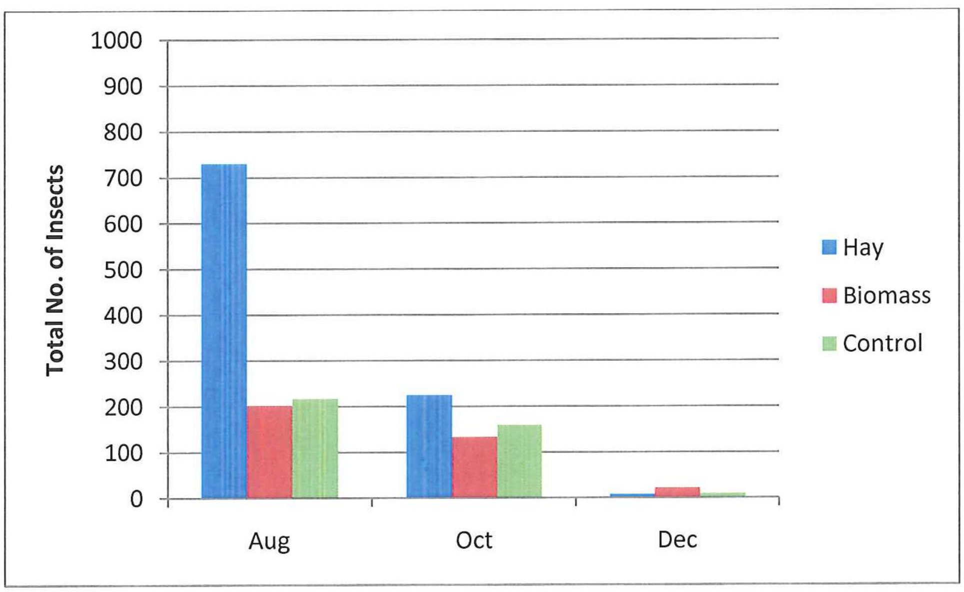

Figure 2b. Total number of invertebrates captured by vertical sticky traps.

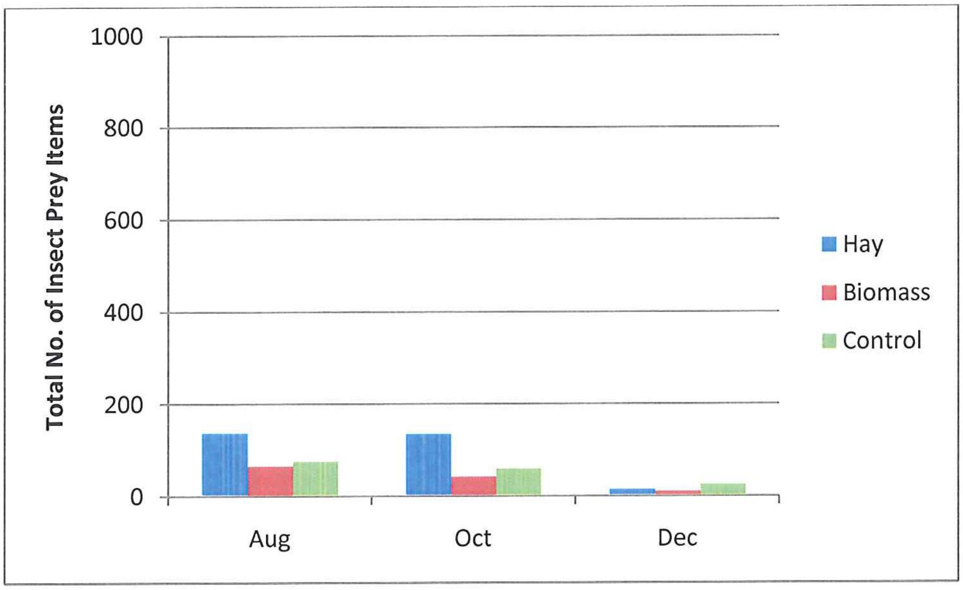

Figure 2c. Total number of invertebrates captured in pitfall traps.

The "Hay" treatment had the highest number of invertebrates with all 3 trapping methods particularly in the August (immediately post harvest) period. There was a marked decrease in overall invertebrate numbers during the December period which occurred after several hard frost events. We observed little difference between the Biomass and Control treatments in all cases.

We examined the composition of invertebrate catches for each trap type and period (Table 1). Dipterans dominated the catch for each of the trapping methods and periods except for pitfall traps in the December period where ants (Formicidae) had the highest observed abundance.

Seeds

In addition to invertebrates, the sticky and pitfall traps were examined for seeds (Table 2). A total of 69 seeds were captured by the 3 trapping methods over the entire sampling period. Of these, 90% of the seeds were from *Panicum virgatum* (the remaining seeds were predominantly *A. girardii*).

Table 1. Proportion of each invertebrate group captured by trap type and total catch (N = 4,498)

Invertebrate Group	Proportion of total capture for type Horizontal	Vertical	Pitfall	% of Total
Insects				
Order Coleoptera	0.0%	0.2%	3.0%	0.4%
Order Diptera	92.7%	82.7%	38.2%	83.0%
Order Hemiptera	0.0%	0.0%	0.2%	0.0%
Order Homoptera	4.0%	11.9%	2.2%	6.7%
Order Hymenoptera - Family Apidae	1.1%	1.7%	7.8%	2.1%
Order Hymenoptera - Family Formicidae	0.1%	0.1%	13.1%	1.6%
Order Lepidoptera - adult	0.2%	0.2%	0.0%	0.2%
Order Lepidoptera - larva	0.0%	0.0%	0.8%	0.1%
Order Neuroptera	1.5%	2.8%	0.0%	1.8%
Order Orthoptera	0.0%	0.2%	1.2%	0.2%
Other Invertebrates				
Other - Order Araneae	0.4%	0.1%	5.6%	0.9%
Other - Class Diplopoda	0.0%	0.0%	1.4%	0.2%
Other- Class Gastropoda	0.0%	0.0%	0.6%	0.1%
Other - Order Isopoda	0.0%	0.0%	11.0%	1.2%
Other - Order Opiliones	0.0%	0.0%	14.3%	1.6%
Other - Subclass Oligochaeta	0.0%	0.0%	0.6%	0.1%
Total	100.0%	100.0%	100.0%	100.0%

Table 2. Total number of seeds for each treatment and sampling period. The number of seeds/m2 was calculated by determining the effective area of each trap.[1]

Treatment	Aug No.	Aug seeds/m^2	Oct	Oct seeds/m^2	Dec	Dec seeds/m^2
Hay	6	337	5	502	3	118
Biomass	12	572	7	478	4	259
Control	13	612	12	878	7	376

Discussion

Our pilot project attempted to identify potential impacts to wildlife habitat value by measuring food availability between NWSG stands under 3 different biomass management regimes. Our objective was to determine the differences in available food items during the summer and fall between NWSG stands

[1] Area of sticky traps was 10 cm x 25.5 cm (0.0255 m^2); diameter of pitfall traps was 9.5 cm (.070882 m^2)

managed for biomass, and to compare the strengths and weaknesses of the different methods available for assessing insect abundance and diversity in these stands.

This project was carried out in a single field with only 1 replicate for the 3 treatments therefore no statistically supported conclusions are possible. The study was an observational effort aimed at providing some basic information on the potential effects of biomass systems on habitat components; namely seed and invertebrate availability.

We were unable to complete the harvest treatments in a manner consistent with a true Hay or Biomass harvest (we removed the standing NWSG by hand) and therefore could only establish a cutting 3 m to either side of the transect. This opening was likely too small to truly emulate the overall impacts of a field harvest and impacted our observations of both invertebrates and seed availability.

With the exception of the December period, the Hay treatment had more invertebrates than either the biomass or control treatments. The biomass and control treatments were very similar in pattern which is to be expected since no treatment activities took place until the December period. Since virtually no invertebrates were captured during this sampling period we observed little difference between these 2 treatments.

The number of invertebrates observed in the Hay treatment was high relative to the other treatments. However, further analysis showed that the majority of these invertebrates were Dipterans. It is very likely that our use of yellow sticky traps increased the number of individuals captured and biased our ability to effectively compare between trap types. The removal of the NWSG during treatment may have increased the visibility of both the horizontal and vertical sticky traps thus attracting Dipterans from the surrounding area. This effect persisted through the October sampling period even though grass cover slightly increased. Given this likely effect, it is premature to conclude with any certainty that there are more invertebrates (primarily Dipterans) available in hay treatments than either the biomass or control areas.

Overall, the Dipterans dominated the invertebrate sample for each treatment and period (83%). If we removed the Dipterans from the analysis, the next most common Orders were Homoptera (39%), Hymenoptera (12%), and Neuroptera (11%). All of these orders are might also be grouped into "flying insects" and further point to the sticky traps actively catching these groups. When we examined only the pitfall traps (thus eliminating the bias associated with attracting animals to the traps) we found that Dipterans comprised the largest proportion of the total sample (38%) which suggests that they are still more abundant than other invertebrate taxa in these NWSG stands. This observation is noteworthy since pitfall traps would not be expected to trap flying insects as efficiently as other methods.

Invertebrate groups often identified as preferred prey for grassland birds include Orthoptera, Coleoptera, larval Lepidoptera, and spiders were scarce relative to the abundance of flies. This observation suggests that NWSG stands managed for biomass (i.e., low plant diversity, at high uniform density) do not provide sufficient habitat for these groups, perhaps due to the relatively low plant diversity, low heterogeneity of vertical structure, digestibility of NWSG, or other factors. We may have observed a higher capture rate of these species with a different sampling methodology such as sweep netting.

The observed capture rate for seeds was relatively low so extrapolation of this data to the treatment level is tenuous. We did observe more seeds in the Control treatment in all periods which suggests that the removal of NWSG during the summer hay period results in a reduction of the overall available seed later in the year. However, we did not place traps in the field until immediately after our harvest treatments were completed. Therefore, seeds dislodged during the cutting activity would not have been captured thus biasing the results. In the future, we will address this by maintaining seed rain traps in the field through the duration of the sampling period, rather than relying on sticky cards for seed rain capture.

Conclusions

In summary, the conclusions derived from this study are:

- Summer haying of biomass crops may reduce seed production and subsequent availability in later parts of the season.
- The invertebrate community observed appears to be dominated by Dipterans.
- The trapping methods used for invertebrates likely biased our results and did not meet our expectations as effective for sampling seeds.
- Treatment effects employed were likely insufficient to truly emulate the target conditions under real-world applications.

Future investigations should employ a more effective method for sampling seed availability in the stand perhaps through direct ground counts or dedicated seed traps. Invertebrate sampling should be completely passive as to allow meaningful comparisons between methods. We suggest using a non-attracting media for deploying horizontal sticky traps (e.g., neutral colors) along with pitfall traps and other active sampling techniques (e.g., sweep netting).

To expand these efforts, we envision establishment of dedicated seed and insect monitoring at previously established sites where access to hay mowing equipment and hay contractors has been settled in advance. For example, CMI has established long-term agreements with several state facilities (e.g., Powhatan Wildlife Management Area and Catawba Sustainability Center) and private landowners around the state to measure forage yield, forage quality, and carbon sequestration under NWSG stands. Superimposing an insect and seed monitoring effort onto these studies would alleviate the hay contracting issue, and allow us to deploy these methods across a diversity of NWSG habitats and management approaches in Virginia.

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