

MOB GRAZING, FROM PEOPLE TO PASTURES:  
WEED BIOLOGY, PASTURE PRODUCTIVITY,  
AND FARMER PERCEPTION AND ADOPTION

Anders M. Gurda

A thesis submitted in partial fulfillment of  
the requirements for the degree of

Master of Science  
(Agroecology)

at the

UNIVERSITY OF WISCONSIN-MADISON

2014

## **Acknowledgments**

I'd first like to express a deep gratitude and debt to Dr. Mark Renz for his skillful mentorship and teaching- he helped me to learn the language of science and to find an informed middle way, beyond the myopic dogmas found in modern agricultural discourse. I'm also grateful to the other members of my committee, Dr. Geoff Brink and Dr. Michael Bell, for guidance and support. The Renz lab, including John Albright, Brendon Panke, Niels Jorgenson and Chelsea Zegler all offered valuable assistance, from material acquisition to music recommendations to hours spent grinding samples. Rhonda Gildersleeve and Laura Paine offered expert grazing insight that helped to increase the utility of this study. Research collaborators Arin Crooks (Lancaster agricultural research station), Jon Bleier (Dairy Forage Research Center), and Rambr Emrich (farmer), made this project happen and provided not only animals, but expert herd management assistance and guidance. I'm also grateful to have had such an amazingly supportive partner in Kitt- meals cooked, shoulders rubbed, and creative distractions offered. Lastly, a huge thank you to the Midwestern grazing community for your understated radicalness, for your survey responses, and for welcoming us researchers into your discussions and onto your farms. Yours is a truly beneficent agriculture.

**Table of Contents****Page**

|   |     |
|---|-----|
| Acknowledgements  | ii  |
| List of tables  | v   |
| List of appendices  | vii |
| <br>  |     |
| Chapter 1: Canada thistle Suppression and Forage Production in Mob<br>Grazed Pastures | 1   |
| Abstract  | 1   |
| Introduction  | 2   |
| Materials and methods   | 5   |
| Site description  | 5   |
| Experimental design   | 6   |
| Grazing protocol and maintenance  | 7   |
| Measurements  | 8   |
| Statistical analysis  | 9   |
| Results and discussion  | 9   |
| Canada thistle density  | 9   |
| Pasture productivity  | 13  |
| Forage utilization  | 14  |
| References  | 18  |
| Tables  | 26  |

|  |    |
|--|----|
| Chapter 2: Defining mob grazing in the Upper Midwestern states | 33 |
| Abstract   | 33 |
| Introduction   | 34 |
| Survey methods and analysis                                    | 37 |
| Description of respondents                                     | 38 |
| Definitions, benefits, and drawbacks                           | 39 |
| Information distribution                                       | 42 |
| Perceptions of mob grazing                                     | 43 |
| A Midwestern mob grazier                                       | 44 |
| References   | 46 |
| Tables   | 50 |
| Appendix A.  | 60 |

## List of tables

### Chapter 1

**Table 1.** Effects of four grazing treatments on Canada thistle stem density at three study locations across two years.

**Table 2.** Effects of four grazing treatments on forage biomass production, forage utilization, and percent utilization in temperate pastures at Hollandale, WI in 2012.

**Table 3.** Effects of four grazing treatments on forage biomass production, forage utilization, and percent utilization in temperate pastures at Hollandale, WI in 2013.

**Table 4.** Effects of four grazing treatments on forage biomass production, forage utilization, and percent utilization in temperate pastures at Prairie Du Sac, WI in 2012.

**Table 5.** Effects of four grazing treatments on forage biomass production, forage utilization, and percent utilization in temperate pastures at Prairie Du Sac, WI in 2013.

**Table 6.** Effects of four grazing treatments on forage biomass production, forage utilization, and percent utilization in temperate pastures at Lancaster, WI in 2012.

**Table 7.** Effects of four grazing treatments on forage biomass production, forage utilization, and percent utilization in temperate pastures at Lancaster, WI in 2013.

### Chapter 2

**Table 1.** Defining mob grazing in the upper Midwestern United States.

**Table 2.** Perceived benefits of mob grazing pastures in the upper Midwestern United States.

**Table 3.** Perceived disadvantages of mob grazing pastures in the upper Midwestern United States.

**Table 4.** Sources of information about mob grazing and their impact as identified by producers using rotational grazing in the upper Midwestern United States.

**Table 5.** Opinions about mob grazing, both in sources of information and personal opinions.

**Table 6.** Seasonality of mob grazing use among self-identified mob graziers.

## **List of appendices**

### **Chapter 2**

Appendix A. Survey questions

## Chapter 1

### Canada thistle Suppression and Forage Production in Mob Grazed Pastures

**Abbreviations:** H-Rgraze 2yrs, herbicide application before treatment application followed by two consecutive years of rotational grazing; Mob 2yrs, two consecutive years of Mob grazing; Mob/Rgraze, one year of Mob grazing followed by one year of rotational grazing; Rgraze 2yrs, two consecutive years of rotational grazing; ; CT, Canada thistle

#### **Abstract**

Canada thistle infestations can negatively affect pasture-based livestock systems by reducing forage production and utilization. Herbicides effectively suppress Canada thistle but also injure forage legumes, an important component in Midwestern pastures. Further, producers working in organic production systems don't have access to chemical control and therefore need alternative suppression strategies. This study compared the efficacy of a fall herbicide application followed by rotational grazing; two mob grazing treatments (one year followed by rotational grazing and two consecutive years); and a rotationally grazed control on Canada thistle density and the resulting forage production and utilization. Rotationally grazed treatments were grazed 3-4 times and Mob grazed plots were grazed twice, once in the spring and once in the fall, in 2012 and 2013. Herbicide application followed by two years of rotational grazing was the most effective treatment across both years and all sites with substantial control lasting two years. By spring 2014,

Canada thistle density had increased two to four fold in Mob grazed treatments at two of three sites compared to the rotationally grazed plots. At a third site non-significant reductions in stem density were observed. Mob grazing for two years increased forage production by 24-76% compared to the rotational control and those treated with a herbicide across sites in 2013. At the most productive site, herbicide application reduced clover and other broadleaf biomass, causing a 25-38% reduction in forage production when compared to rotationally grazed treatments. Mob grazing increased Canada thistle utilization at one of three sites compared to rotational grazing. While mob grazing did not provide improved thistle suppression after two years, the potential for increases in forage availability and utilization suggest that mob grazing may provide benefits beyond thistle control for producers. Additionally, reductions in forage production resulting from herbicide application in legume-rich pastures recommend further research into viable alternative control methods.

### **Introduction**

Management intensive rotational grazing has become an established practice throughout Wisconsin and the Upper Midwest due to its economic, environmental, and production benefits (Dartt et al. 1999; Paine and Gildersleeve, 2011; Taylor and Foltz, 2006; Lyons et al. 2000). One such benefit is the prevention of weed emergence and suppression of infestations by competitive, desirable forage species in pastures that are managed using rotational grazing (Wardle et al. 1995; Trumble and Kok 1982). While weed species are less common in rotationally grazed

pastures, weed infestations can still occur. Canada thistle (*Cirsium arvense* L.) (hereafter CT) has been identified as a weed of particular concern in temperate regions (Moore 1975). CT can reduce the production and utilization of desirable forage which can result in losses in animal performance (Undersander et al. 2002). For example, desirable yield losses caused by Canada thistle presence have been estimated at 2 kg ha<sup>-1</sup> for each kilogram of thistle biomass (Grekul and Bork 2004). In addition, Canada thistle's spiny leaves can reduce forage utilization by up to 60% (De Bruijn and Bork 2006).

While weed control is desired by producers, Canada thistle is notably hard to suppress due to its aggressive perennial roots (Moore 1975). Most research conducted on controlling Canada thistle in pastures and grasslands has focused on the use of herbicides, many of which, though effective (Enloe et al. 2007), can cause injury to clover populations (Bork et al. 2007) and are not registered for use in organic systems (National Organic Program). One alternative to chemically-intensive control is altering grazing to improve suppression. It has been documented that control of weed species can be enhanced by increasing weed utilization by animals (Rinella 2009; Peterson 2013), physically injuring the weed with hoof action (Popay and Field 1996), and encouraging rapid forage regrowth that facilitates interspecific competition (De Bruijn et al. 2010).

Rotational grazing systems can be modified to maximize the aforementioned impacts on Canada thistle. Mob grazing is one such practice, described by Allen et al. (2011) as Mob stocking and defined as "A method of stocking at a high grazing pressure for a short time to remove forage rapidly as a management strategy."

Among producers and popular press, Mob grazing (sometimes referred to as ultra high stocking density) has been implicated as a grazing management system that suppresses Canada thistle and increases forage production and utilization (Kidwell 2010; Lemus 2011; Johnson 2013). However, there has been little research conducted focusing specifically on Mob grazing or its reported benefits. One study researching big bluestem (*Andropogon gerardii* Vitman) establishment found Mob grazing to be ineffective at controlling weeds when compared with atrazine (Lawrence, 1995), while three experiments effectively used Mob grazing as a technique to decrease selectivity in pasture germplasm and persistence trials (Bittman and McCartney 1993; Gildersleeve 1987; McCartney and Bittman 1994). High intensity low frequency grazing has also been documented to nearly eliminate Canada thistle after three years of grazing (De Bruijn and Bork 2005). Other studies have explored using sheep (Olson and Wallander 2001) and goats (Hejcman et al. 2014) as biological control agents, but few have focused on the use of cattle (Popay and Field, 1996). The limited and conflicting nature of the existing literature on Mob and other high intensity grazing regimes relating to weed control justifies further effort.

Definitions among rotational grazing systems are seldom universally applicable, often making distinctions unclear and confusing. While HILF grazing has been shown to effectively suppress Canada thistle, this terminology appears to be used solely in research communities (Taylor 1993; De Bruijn, 2005). Mob grazing in its most recent incarnation is seen as a producer-generated term used by grazing communities that differs from HILF grazing by using higher stocking densities,

shorter grazing events, longer rest periods, and utilizing more mature forage (Chapter 2, Thomas 2012; Kidwell 2010; Holin 2013). The lack of research exploring grazing and Canada thistle control in the Midwest and the increase in organic grazing operations both support the need for more research. Further, a focus on Mob grazing, an increasingly-adopted but little-studied grazing strategy, provides important information about the utility and productivity of this form of management intensive rotational grazing. The objective of our study was to evaluate the effect of Mob grazing on forage productivity, forage utilization, and Canada thistle suppression compared to other standard practices.

## **Materials and Methods**

**Site description.** Research was conducted at three locations in southern Wisconsin: Lancaster Agricultural Research Station near Lancaster, WI (42° 83'93" N, 90° 79'63" W), a private farm near Hollandale, WI (42°91'50" N, 89°97'92" W), and at the USDA ARS Dairy Forage Research Center farm near Prairie Du Sac, WI (43°34'42" N, 89°71'57" W). The soils at Lancaster and Hollandale are Dubuque and Fayette silt loams respectively (fine-silty, mixed, superactive, mesic typic Hapludalf with 6-20% slopes). The soil at Prairie Du Sac is a Richwood silt loam (fine-silty, mixed, superactive, mesic typic Arguidoll with 0% slope). In 2012, Wisconsin experienced a severe drought with annual precipitation across the three sites averaging 80% of 30 year averages (1971-2000) and June to August precipitation 35 to 50% of averages. Summer temperatures were also above average with a 9 to 11% increase above 30 year averages in July.

Experiments varied in size at each location due to the extent of Canada thistle infestations. The primary forage grasses (>10%) were tall fescue (*Festuca arundinacea* Schreb.) at Lancaster and Kentucky bluegrass (*Poa pratensis* L.) and quack grass (*Elytrigia repens* L.) at both Hollandale and Prairie Du Sac. Dominant legume species (>10%) were Kura clover (*Trifolium ambiguum* M. Bieb.) at Lancaster and red clover (*Trifolium pratense* L.) at Hollandale. Prairie Du Sac had < 5% forage legume present in 2011 with a steady increase throughout the study to >10% in 2014. Dominant weed species (>5% cover) consisted of Canada thistle and dandelion (*Taraxacum officinale* Weber ) at all three sites and wild carrot (*Daucus carota* L.) and wild parsnip (*Pastinaca sativa* L.) at Prairie Du Sac.

Soil samples were taken the fall before study commencement to determine fertilizer recommendations. In 2012 and 2013, diammonium phosphate and potassium chloride were applied in spring and ammonium sulfate was applied spring and fall based on recommendations from soil test results, pasture species composition, and management history (Laboski and Peters 2012).

**Experimental design.** In fall 2011, polywire electric fence was installed, separating treatments within replications at each location. Grazing animals were excluded from plots except during grazing events. Four replications in a randomized complete block design were established with plots 23 by 9 m, 18 by 7.5 m, and 9 by 7.5 m at Lancaster, Prairie du Sac, and Hollandale respectively. Each block consisted of 1) an herbicide application in the fall followed by rotational grazing for two years (H-Rgraze 2yrs), 2) rotational grazing for two years (Rgraze 2 yrs), 3) Mob grazing for

one year followed by one year of rotational grazing (Mob/Rgraze) and 4) Mob grazing for two years (Mob 2yrs). Aminopyralid and 2,4-D at 979 +120 g ae/ha was broadcast across appropriate plots with a hand held boom sprayer in October of 2011 at 140.3 L ha<sup>-1</sup>.

### **Grazing protocol and maintenance**

Beginning in spring 2012, rotationally grazed plots were grazed when mean canopy height was greater than 20 cm and before grasses flowered (3-4 times per year). Mob grazed plots were grazed when mean canopy height was greater than 36 cm, grasses were flowering, and Canada thistle was in flower bud to flowering stage (twice per year). Stocking densities were 67.3 Mg ha<sup>-1</sup> and 448.3 Mg ha<sup>-1</sup> for rotational and Mob treatments respectively. Throughout the growing season each year (April through October) sward heights at each location were visually assessed and grazing treatments were applied when forage grass growth reached the desired height. Plots were grazed or trampled to a 10 cm residual regardless of treatment. Treatments were grazed only if the desired height was reached, thus fewer grazing events and longer inter-grazing periods occurred in 2012 due to drought conditions.

Plots were grazed by cattle breeds that varied depending on location and season: Angus cows and stockers at Lancaster, Holstein heifers at Prairie Du Sac, and Angus (2013) or Jersey stockers and Holstein heifers (2012) at Hollandale. The number of animals herded into each plot was dictated by plot size and desired density to reach the prescribed live weight for each treatment. Depending on

forage maturity and stocking density, the length of grazing period varied, averaging 8-24 hours for Mob plots and 24-48 hours for rotational plots.

**Measurements.** Canada thistle stem density was measured in May and October from fall 2012 through spring 2014. Size of area sampled was approximately 6% of total plot size, thus stems were counted within six, seven, and eight randomly placed 1 m<sup>2</sup> quadrats per plot at Hollandale, Prairie du Sac and Lancaster respectively.

Forage biomass availability and utilization were measured by clipping 3-4 samples per plot, depending on location (3 at Hollandale and 4 at Prairie Du Sac and Lancaster), with a 1 m<sup>2</sup> quadrat split into four 0.25 m<sup>2</sup> sections. Before each grazing event, two of the four sections were selected based on visually assessed similarity in biomass and species composition, one for pre-graze sampling and the other for post-graze sampling. To estimate available biomass, the pre-graze quarter was hand-clipped to 10 cm, after which the soil surrounding the post-graze quarter was outlined with paint for ease in location after the grazing event. Residual sward height was monitored by observation until the desired residual was met, at which point animals were removed from plots and excluded until the desired height and maturity were once again reached. After the grazing event, refused and/or trampled forage was clipped to 10 cm. Subsamples were combined within each plot to determine forage productivity and utilization. Pre- and post-graze forage samples were separated into one of four forage classes (grass, clover, Canada thistle, or other) and were weighed after being dried at 65°C for 48 hours. Forage utilized was calculated as the difference between the pre-graze and post-graze dried forage yield.

Annual available and utilized forage were calculated as the sum of pre-graze and pre minus post-graze samples harvested from each plot summed across all grazing events for each year.

**Statistical Analysis.** Data were not combined over sites or years because of significant interactions between year and site. Because of variable thistle abundance between years and sites, the differential between treatments within any particular year or site is more explanatory than considering absolute numbers over time. Data were analyzed using the aov function in R, (version 3.0.2, 2013, R Core Development Team). Residual vs. fitted plots were used to check for linearity, equal error variances, and outliers and a square root transformation was used when these were not met. If appropriate, means were separated using Tukey's HSD with differences considered significant if  $P \leq 0.10$  to account for the considerable variation often found within grazing studies.

## **Results and Discussion**

### **Canada thistle density**

Herbicide application followed by two years of rotational grazing (H-Rgraze 2 yrs) was found to be the treatment most effective at reducing Canada thistle density. Aminopyralid + 2,4-D reduced CT densities to the lowest levels compared to other treatments across all three sites and timings except for one, demonstrating the effectiveness of this herbicide at suppressing CT for multiple years (Table 1).

Effectiveness of mob grazing compared to other treatments varied by sampling time. One year after the experiment was initiated (fall 2012), Mob grazing reduced CT density 76-98% compared to Rgraze, and suppression was equivalent to or greater than H-Rgraze at all three sites. However, by spring 2013, Mob grazed treatments had similar or more CT stems  $m^{-2}$  compared to Rgraze, and 5 to 40 times more CT than the H-Rgraze treatment at all sites. Differences between fall of 2012 and spring of 2013 may be attributed to the severe drought in 2012 as CT often does not resprout in drought conditions (Wilson 1979).

Two years after the experiment was initiated (Fall 2013), Aminopyralid +2,4-D suppression was visible at only one of the three sites compared to Rgraze treatments. Lancaster maintained an eightfold reduction in CT density, while the other two sites were similar to Rgraze or Mob treated plots for one year. Mob grazing for two years resulted in two to 4 fold greater CT densities across two sites, and similar densities at the third site. The lack of precipitation in 2012 may have been a factor in this observed increase. Bare ground in the Mob grazed plots at all three sites increased three to 32 times over Rgraze by the fall of 2012 (data not shown). This would have resulted in the high temperatures and light intensities that optimize CT germination (Bakker 1960; Moore 1975; Renz and Schmidt 2013). Also bare ground creates points of entry for the vegetative spread of CT (Amor and Harris 1975). It's feasible that the drought year created both bare ground and soil disturbance resulting from grazing less productive pastures, two factors that may have encouraged the CT spread that was observed in the fall of 2013 (Moore 1975; Bakker 1960).

By spring 2014, Canada thistle density remained high in Mob/Mob plots with a six to eightfold increase over Rgraze 2yrs at Prairie du Sac and Hollandale. Conversely, at Lancaster, Mob/Mob reduced Canada thistle stem density by 33% compared to RGraze 2yrs, but was not significantly different than any of the other treatments. Mob grazing for one year had no influence on Canada thistle density, suggesting limited benefit from implementing this approach for one year for weed suppression. While variable, our results contradict those of De Bruijn and Bork (2006) who found that 2-3 years of twice annual intense defoliations nearly eliminated CT stems. The effect of Aminopyralid and 2,4-D was still evident at Lancaster only, with a fourfold reduction in CT density. The other two sites were similar to treatments rotationally grazed for one or two years. Our results agree with other studies with respect to herbicide effectiveness 1 YAT (Enloe et al. 2007). Additionally, Almquist and Lym (2010) found that control begins to decrease slightly by 22 MAT, roughly the same timeframe in which we observed a small increase in CT stems between spring and fall 2013.

While many studies have focused on chemical control, few have directly compared results to different grazing management strategies. Studies that have found grazing treatments to suppress CT often credit interspecific competition as the primary control agent (Pywell et al. 2009), increased in the desirable forage's favor through long rest periods and rapid forage regrowth (De Bruijn et al. 2010; Edwards et al. 2000). The 2012 drought decreased forage production (see tables 2, 4, 6) and likely reduced long-term CT control in our study. Differential results with respect to site may be due to the varying productivity of the pasture sward between

locations. Lancaster experienced the greatest productivity as well as the most even distribution of biomass between grasses and legume forages (Tables 6 and 7). We believe that the further increase in production found in plots Mob grazed for two years resulted in CT suppression. This hypothesis is supported by Tracy and Sanderson (2004) who found that both productive pastures and multiple forage species work in unison to effectively reduce weed populations. Pywell et al. (2009) also found that CT density was primarily affected by the competitiveness of grass species. Thus previous efforts strongly support our hypothesis that the increased productivity and contribution of multiple species observed at Lancaster is an important variable involved in the suppression of CT in any treatment that causes substantial injury or damage (e.g. herbicide, Mob grazing for multiple years).

In contrast, Prairie Du Sac and Hollandale lacked the productivity found at Lancaster. Yield and species differences resulted in 38-45% lower sward heights in mob treatments compared to Lancaster throughout the experiment (data not shown). A significant difference in forage heights was also found between years, with a 26-69% reduction in mean sward height during the drought of 2012. Forage height affects light intensity by intercepting solar radiation before reaching seedlings or the soil surface (Renz and Schmidt 2013), an important factor in weed suppression. CT Seedlings die if light intensity falls below 20% of full daylight, and at 60-70% of full daylight seedlings experience a reduction in growth (Moore 1975). Further, taller forage is often accompanied by a decrease in forage utilization and an increase in trampling as livestock tread on elongated stalks while grazing the more palatable leaves and seed heads. We suggest that in productive pastures, forage

trampling may create a mulch layer that discourages CT germination and establishment. A substantial mulch layer was observed only at Lancaster (personal observation).

### **Pasture Productivity**

Total forage production in 2013 across sites in Mob grazed plots was 24-76% higher than other treatments, though not statistically significant at Lancaster (Tables 6 and 7). Rotationally grazed plots experienced shorter rest periods and more numerous defoliations than Mob grazed plots, inhibiting maximum regrowth and dry matter production. Higher stocking density in Mob grazed plots also allowed for increased and more even manure deposition which also may have enhanced productivity (Hansen 1996; Sanderson and Jones 2013).

Herbicides, though found to effectively control CT, also decreased non-target clover populations by 95 to 100% at all three sites 1 year after treatment (tables 2, 4, and 6). These findings align with Bork et al. (2007) who found that herbicides reduced non-thistle forbs 1 YAT. However, whereas they found an increase in grass production with decreases in forb and legume density, this pattern was not observed at any site for either year in our study. Further, total forage biomass was negatively affected by herbicide application at Lancaster when compared with RGraze 2yrs and Mob 2yrs (tables 6 and 7). This decrease in productivity is explained by reductions in all forb classes, including clovers, CT, and “other” which includes various weedy species such as dandelion (*Taraxacum officinale* Weber), wild carrot (*Daucus carota* L.), and wild parsnip (*Pastinaca sativa* L.), many of which

are of acceptable forage quality when in vegetative growth stages (De Bruijn and Bork, 2006; Marten et al. 1987). Mob 2yr also reduced clover biomass 2YAT at all three sites compared to Rgraze 2yrs, agreeing with Pywell et al. (2009) who found that grazing regimes with taller residual sward height reduced non-target forb diversity. Increasing manure deposition, as happens in Mob grazed plots, may also be a reason for reduced clover biomass (Hansen 1996).

While Mob grazing for 2years decreased clover biomass, it increased CT biomass across all sites during the second year. CT biomass was highest in Mob 2yrs at all locations compared to other treatments, two of them significantly. It is unclear if this result indicates an increase in CT populations or a transfer of below ground energy reserves aboveground. If the latter is true, this is a requirement to improve long-term control of CT. Often not realized; however, is that CT is of high nutritive value, particularly in the earlier stages of growth (Marten et al. 1987, De Bruijn and Bork, 2006). Therefore, depending on when defoliation occurs, an increase in CT biomass could be seen as a productive contribution to the overall pasture portion of an animal's diet, especially if CT utilization can be increased through changing livestock behavior, such as through Mob grazing

1

## 2 **Forage Utilization**

3 Forage utilization generally followed the same pattern as forage productivity,  
4 when more forage was available, more was utilized. At Prairie Du Sac, the least  
5 productive site, CT and total utilization were consistently the highest in Mob grazed  
6 plots in both 2012 and 2013 (tables 4 and 5). Whereas at Lancaster, the most

7 productive site, grass tended to be less utilized in Mob grazed plots than in other  
8 treatments in 2012 and more utilized in 2013 (tables 6 and 7). The drought year of  
9 2012 was accompanied by a very early spring that allowed forages to reach  
10 advanced maturity before CT reached bud stage in mob plots. Much of this mature  
11 forage was trampled before it could be utilized, and once soiled, was refused by  
12 grazing livestock. In 2013 however, an average spring allowed CT plants to reach  
13 bud stage before forages reached full maturity, thus forage was more palatable than  
14 the previous year, decreasing trampling and increasing utilization to levels  
15 comparable to other treatments. Additionally, CT production increased in 2013 with  
16 utilization increasing accordingly, driving up overall consumption. We believe that  
17 the high level of grass, CT, and total forage utilization in Mob plots at Prairie Du Sac  
18 can be explained by the lower mean sward height and decreased biomass  
19 production. Because there was less forage to refuse and/or trample, the cattle  
20 utilized 1.5-2.5 times more total forage when compared with RGraze 2 yrs. At  
21 Hollandale, total utilization was not significantly different between treatments for  
22 either year (tables 2 and 3).

23         The relationship between productivity and utilization is also evident in  
24 relative forage utilization. At the less productive Prairie Du Sac, total percent  
25 utilization is 19-30% lower in RGraze than in Mob grazed plots, while at Lancaster in  
26 2012, utilization is 25% lower in Mob than RGraze plots (see above) and not  
27 different in 2013. Percent CT utilization generally followed the same pattern as  
28 percent total utilization save for a notable reversal at Lancaster in 2012. While total  
29 utilization was 25% lower in Mob 2yrs than Rgraze 2 yrs, CT utilization was

30 increased by 66% in Mob plots compared to RGraze in 2012 and by 94% in 2013,  
31 though only significant in 2012. These results suggest that the decreased selectivity  
32 which leads to CT herbivory in high-intensity low frequency grazing described by De  
33 Bruijn and Bork (2006) and Peterson et al. (2013) is also evident in Mob grazing  
34 systems.

35         Some have suggested that grazing behavior is partially socially facilitated,  
36 with grazing animals learning what plants are palatable or poisonous through  
37 observation and mimicry (Ralphs and Provenza, 1999). At Prairie Du Sac and  
38 Lancaster, small herd sizes ensured that the same animals were used in all plots for  
39 the entire grazing season, allowing ample time for socialization that may have  
40 included CT utilization behavior spreading among the herd. Hollandale had the  
41 largest herd and the smallest plots, decreasing the chances of animals repeatedly  
42 being used in research plots, decreasing the potential for socialization relating to CT  
43 utilization at high stock densities.

44         Through increasing stocking density and lengthening rest periods, forage  
45 production and utilization, including CT production and utilization generally  
46 increased, agreeing with De Bruijn and Bork's (2006) findings. However, in contrast  
47 to their conclusions, we did not observe suppression of Canada thistle. It's possible  
48 that Wisconsin's longer growing season allows for greater CT persistence than in  
49 the Aspen Parkland ecoregion in central Alberta, where their research was  
50 conducted. Additionally, grazing protocols differed, with De Bruijn and Bork's  
51 including shorter post-graze residual (2 cm) and increased utilization and CT  
52 damage through longer grazing periods (De Bruijn and Bork 2006). Our hesitance to

53 lengthen grazing periods resulted from a desire to closely mimic producer behavior  
54 so as to enhance potential adoption of the researched practices. Further, they found  
55 additional decreases in CT density after a third year of high-intensity grazing, with  
56 our study running for only two. While the version of Mob grazing that we applied to  
57 Wisconsin pastures proved not to be as effective as herbicide application in  
58 suppressing CT and increased thistle density at two out of three sites, at a third site  
59 we observed enhanced thistle control in plots that had been Mob grazed for two  
60 years. However, the patchy and unpredictable nature of Canada thistle created  
61 variability that eliminated statistical significance (Eber and Brandl, 2003).

62         We hypothesize that pasture productivity enhanced interspecific competition  
63 in favor of desirable forages, and may be an important factor in Canada thistle  
64 suppression in conjunction with Mob grazing, as others have documented (Edwards  
65 et al. 2000; Pywell et al. 2009). Additionally, the higher mean sward height resulting  
66 from long rest periods in Mob grazed plots decreased light infiltration and increased  
67 the amount of trampled forage, potentially introducing smothering as a mode of  
68 action. Lastly, tempering the lack of CT suppression is the increase in forage biomass  
69 produced and utilized in Mob grazed plots, a windfall for producers desiring  
70 increased forage production. Given that benefits beyond potential Canada thistle  
71 control may result from Mob grazing, it's clear that more region-specific research  
72 exploring the role of grazing in weed control is needed, as well as fine-tuning  
73 grazing management to maximize production together with potential weed  
74 suppression.

75

76

77 **References**

78

79 Allen, V. G., C. Batello, E. J. Berretta, J. Hodgson, M. Kothmann, X. Li, J. McIvor, J. Milne,  
80 C. Morris, A. Peeters, and M. Sanderson. 2011. An international terminology for  
81 grazing lands and grazing animals. *Grass and Forage Science*, 66: 2-28.

82

83 Almquist, T. L. and R. G. Lym. 2010. Effect of Aminopyralid on Canada thistle  
84 (*Cirsium arvense*) and the native plant community in a restored tallgrass prairie.  
85 *Invasive Plant Science and Management* 3(2): 155-168.

86

87 Amor, R. L., R. V. Harris. 1975. Seedling establishment and vegetative spread of  
88 *Cirsium arvense* (L.) Scop. In Victoria, Australia. *Weed Research* 15: 407-411.

89

90 Bakker, D. 1960. A comparative life history study of *Cirsium arvense* (L.) Scop. And  
91 *Tussilago farfara* L. the most troublesome weeds in the newly reclaimed polders of  
92 the former Zuiderzee. J. L. Harper, ed. *The biology of weeds*. Blackwell, Oxford.

93

94 Bittman, S., D. H. McCartney. 1993. Evaluating alfalfa cultivars and germplasms for  
95 pastures using the Mob-grazing technique. *Canadian Journal of Plant Science* 74(1):  
96 109-114.

97

- 98 Bork, E. W., C. W. Grekul, S. L. DeBruijn. 2007. Extended pasture forage sward  
99 responses to Canada thistle (*Cirsium arvense*) control using herbicides and  
100 fertilization. *Crop Protection* 26:1546-1555.
- 101
- 102 De Bruijn, S. & E Bork. 2006. "Biological control of Canada thistle in temperate  
103 pastures using high density rotational cattle grazing." *Biological Control*, Vol. 36: pp  
104 305-315.
- 105
- 106 De Bruijn, S. E. Bork, and C. Grekul. 2010. "Neighbor defoliation regulates Canada  
107 thistle (*Cirsium arvense*) in pasture by mediating interspecific competition." *Crop*  
108 *Protection*, Vol. 29: pp.1489-1495.
- 109
- 110 Dartt, B. A., J. W. Lloyd, B. R. Radke, J. R. Black, and J. B. Kaneene. 1999. A comparison  
111 of profitability and economic efficiencies between management-intensive grazing  
112 and conventionally managed dairies in Michigan. *J. Dairy Sci.* 82:2412-2420.
- 113
- 114 Eber, S. and R. Brandl. 2003. Regional patch dynamics of *Cirsium arvense* and  
115 possible implications for plant-animal interactions. *Journal of Vegetation Science* 14:  
116 259-266.
- 117
- 118 Edwards, G. R., G. W. Bourdot, M. J. Crawley. 2000. Influence of herbivory,  
119 competition and soil fertility on the abundance of *cirsium arvense* in acid grassland.  
120 *Journal of Applied Ecology* 37: 321-334.

121

122 Enloe, Stephen F., R. G. Lym, R. Wilson, P. Westra, S. Nissen, G. Beck, M. Moechnig, V.  
123 Peterson, R. A. Masters, and M. Halstvedt. 2007. Canada thistle (*Cirsium Arvense*)  
124 control with Aminopyralid in range, pasture, and noncrop areas. *Weed Tech*, 21(4):  
125 890-894.

126

127 Gildersleeve, R.R., W. R. Ocumpaugh, K. H. Quesenberry, and J. E. Moore. 1987. Mob-  
128 grazing of morphologically different *Aeschynomene* species. *Tropical Grasslands*  
129 21(3): 123-132.

130

131

132 Grekul, C., D. Cole, and E. Bork. 2005. "Canada thistle (*Cirsium arvense*) and pasture  
133 forage responses to wiping with various herbicides." *Weed Technology*, Vol. 19(2):  
134 pp 298-306.

135

136 Grekul, C. W., & Bork, E. W. 2004. *Weed Technology*, 18(3), 784-794.

137

138 Hansen, Sissel. 1996. Effects of manure treatment and soil compaction on plant  
139 production of a dairy farm system converting to organic farming practice.

140 *Agriculture, Ecosystems & Environment*, 56(3): 173-186.

141

- 142 Hejcman, M., L. Strnad, P. Hejcmanova, and V. Pavlu. 2014. Biological control of  
143 *Rumex Obtusifolius* and *Rumex crispus* by goat grazing. *Weed Biology and*  
144 *Management*. doi: 10.1111/wbm.12038
- 145
- 146 Holin, F. 2013. Mob grazing: a tool, not a master plan. *Hay & Forage Grower*.
- 147 Hunter, J. H., A. I. Hsiao, and G. I. McIntyre. 1985. Some effects of humidity on the  
148 growth and development of *Cirsium arvense*. *Bot. Gaz.* 146:483-488.
- 149
- 150 I. Popay and R. Field. 1996. "Grazing animals as weed control agents." *Weed*  
151 *Technology*, Vol. 10: pp. 217-231. Accessed March 23, 2013.
- 152
- 153 Kidwell, B. (2010, March). Mob grazing. *Angus Beef Bulletin*, Retrieved from  
154 [http://www.angusbeefbulletin.com/ArticlePDF/MobGrazing\\_03\\_10\\_ABB.pdf](http://www.angusbeefbulletin.com/ArticlePDF/MobGrazing_03_10_ABB.pdf)  
155 Accessed March 23, 2013.
- 156
- 157 Laboski, Carrie A. M. and J. B. Peters. 2012. Nutrient application guidelines for field,  
158 vegetable, and fruit crops in Wisconsin (A2809). Cooperative Extension Publishing.  
159 [learningstore.uwex.edu/assets/pdfs/A2809.pdf](http://learningstore.uwex.edu/assets/pdfs/A2809.pdf)
- 160
- 161 Lawrence, B. K., S. S. Waller, L. E. Moser, B. E. Anderson, L. L. Larson. 1995. Weed  
162 suppression with grazing or atrazine during big bluestem establishment. *Journal of*  
163 *Tange Management* 48(4): 376-379.
- 164

- 165 Lemus, R. 2011. What is Mob grazing and does it really provide grazing advantages?.
- 166 Mississippi State University Extension Service Forage News 4: 7.
- 167
- 168 Lyons, J., B.M. Weigel, L. K. Paine, and D. J. Undersander. 2000. Influence of intensive
- 169 rotational grazing on bank erosion, fish habitat quality, and fish communities in
- 170 southwestern Wisconsin trout streams. *Journal of Soil and Water Conservation*
- 171 55:271-276.
- 172
- 173 Marten, G. C., C. C. Sheaffer, D. L. Wyse. 1987. Forage nutritive value and palatability
- 174 of perennial weeds. *Agronomy Journal* 79:980-986.
- 175
- 176 McCartney, D. H., S. Bittman. 1994. Persistence of cool-season grasses under grazing
- 177 using the Mob-grazing technique. *Canadian Journal of Plant Science* 74(4): 723-728.
- 178
- 179 "National Organic Program," Title 7 *Code of Federal Regulations*, Pt. 205. 2014 ed.
- 180
- 181 Olson, B. E. and R. T. Wallander. 2001. Sheep grazing spotted knapweed and Idaho
- 182 fescue. *J. Range Manage.* 54: 25-30.
- 183
- 184 Paine, L., and R. Gildersleeve. 2011. A summary of dairy grazing practices in
- 185 Wisconsin. Wisconsin Department of Agriculture, Trade, and Consumer Protection.
- 186 <http://datcp.wi.gov/uploads/Farms/pdf/2011DairyGrazingSummary.pdf> (accessed
- 187 2/1/14).

188

189 Paine, L., and R. Gildersleeve. 2011. A summary of beef grazing practices in

190 Wisconsin. University of Wisconsin Extension.

191 <http://fyi.uwex.edu/grazres/files/2011/05/2011-Beef-Grazing-Summary->

192 FINAL.pdf (accessed 2/1/13).

193

194 Peterson, D., M. Brownlee, T. Kelley. 2013. Stocking density affects diet selection.

195 *Rangelands* 35(5): 62-66.

196

197 Pywell, R. F., M. J. Hayes, J. B. Tallowin, K. J. Walker, W. R. Meek, C. Carvell, L. A.

198 Warman, and J. M. Bullock. 2009. Minimizing environmental impacts of grassland

199 weed management: can *Cirsium arvense* be controlled without herbicides? *Grass*

200 and *Forage Science* 65: 159-174.

201

202 Ralphs, M. H., F. D. Provenza. 1999. Conditioned food aversions: principles and

203 practices, with special reference to social facilitation. *Proc Nutr Soc.* 58(4): 813-820.

204

205 Renz, M. J. and M. L. Schmidt. 2012. The Effects of Increasing Grazing Height

206 on Establishment of Pasture Weeds in Management-Intensive Rotationally

207 Grazed Pastures. *Weed Science* 52:14-23.

208

209 Rinella, M. J. and B. J. Hileman. 2009. Efficacy of prescribed grazing depends on

210 timing intensity and frequency. *Journal of Applied Ecology* 46: 796-803.

211

212 R. J. Moore. 1975. "The biology of Canadian weeds." *Canadian Journal of Plant*  
213 *Science*, Vol. 55: pp. 1033-1048.

214

215

216 Sanderson, M. A. and R. M. Jones. 2013. Forage yields, nutrient uptake, soil chemical  
217 changes, and nitrogen volatilization from bermudagrass treated with dairy manure.  
218 *Journal of Production Agriculture*, 10(2): 266-271.

219

220 Taylor, J., and J. Foltz. 2006. Grazing in the dairy state: Pasture use in the Wisconsin  
221 dairy industry, 1993-2003. Center for Integrated Agricultural Systems & Program on  
222 Agricultural Technology Studies, University of Wisconsin, Madison, WI.

223

224 Taylor J. R., C. A., T. D. Brooks, N. E. Garza. 1993. Effects of short duration and high-  
225 intensity, low frequency grazing systems on forage production and composition. *J.*  
226 *Range Manage.* 46: 118-121.

227

228 Thomas, H. S. 2012. Ranchers sing the praises of Mob grazing of cattle. *Beef.*  
229 [http://beefmagazine.com/pasture-range/ranchers-sing-praises-Mob-grazing-](http://beefmagazine.com/pasture-range/ranchers-sing-praises-Mob-grazing-cattle?page=1)  
230 [cattle?page=1](http://beefmagazine.com/pasture-range/ranchers-sing-praises-Mob-grazing-cattle?page=1)

231

- 232 Tracy, B. F., M. A. Sanderson. 2004. Forage productivity, species evenness and weed  
233 invasion in pasture communities. *Agriculture, Ecosystems and the Environment*  
234 102: 175-183.
- 235
- 236 Trumble, J. T., and L. T. Kok. 1982. Integrated pest management techniques in thistle  
237 suppression in pastures of North America. *Weed Research* 22: 345-359.
- 238
- 239
- 240 Undersander, D., Albert, B., Cosgrove, D., Johnson, D., and P. Peterson. 2002. Pastures  
241 for profit: A guide to rotational grazing. University of Wisconsin Extension. A3529,  
242 pp. 1-38.
- 243
- 244 Wardle, D.A., Nicholson, K. S., Ahmed, M., and A. Rahman. 1995. Influence of Pasture  
245 Forage Species on Seedling Emergence, Growth and Development of *Carduus*  
246 *nutans*. *The Journal of Applied Ecology*, Vol. 32(1):225-233.
- 247
- 248 Wilson, R. G. Jr. 1979. Germination and seedling development of Canada Thistle  
249 (*Cirsium arvense*). *Weed Science*, 27(2): 146-151.
- 250
- 251

252

253 **Table 1.** Effects of four grazing treatments on Canada thistle stem density at three study locations across two years.

254 Treatments evaluated include 1) an herbicide application followed by rotational grazing for two years (H-Rgraze 2 yrs), 2)

255 rotational grazing for two years (Rgraze 2 yrs), 3), Mob grazing for one year followed by one year of rotational grazing

256 (Mob/Rgraze) and 4) Mob grazing for two years (Mob 2 yrs). Treatments were replicated four times at each site. Letter codes

257 indicate significance of pairwise tests within columns.

258

| Treatment      | Canada thistle stem density (shoots/m <sup>2</sup> ) |        |        |       |                |         |        |        |           |         |         |        |
|----------------|--|--------|--------|-------|----------------|---------|--------|--------|-----------|---------|---------|--------|
|                | Hollandale   |        |        |       | Prairie Du Sac |         |        |        | Lancaster |         |         |        |
|                | F '12  | S '13  | F '13  | S '14 | F '12          | S '13   | F '13  | S '14  | F '12     | S '13   | F '13   | S '14  |
| H-Rgraze 2 yrs | 0.6 b  | 1.8 b  | 2.3 b  | 0.4 b | 0.9 b          | 1.3 c   | 2.5 b  | 1.3 b  | 0.4 c     | 0.3 b   | 3.6 b   | 5.7 b  |
| Mob/Rgraze     | -  | -      | 3.5 b  | 0.9 b | -              | -       | 7.1 ab | 4.1 ab | -         | -       | 23.9 a  | 21.9 a |
| Mob 2 yrs      | 0.4 b†   | 9.5 a† | 14.2 a | 5.5 a | 0.1 c†         | 11.6 a† | 12.5 a | 7.3 a  | 4.5 b†    | 14.3 a† | 12.9 ab | 16 ab  |
| Rgraze 2 yrs   | 1.7 a  | 7.6 a  | 4.3 b  | 0.8 b | 4 a            | 4.2 b   | 3.4 b  | 0.9 b  | 17.4 a    | 15.4 a  | 24.9 a  | 24 a   |
| p-value        | <0.01  | <0.01  | <0.01  | <0.01 | <0.01          | <0.01   | <0.01  | 0.01   | <0.01     | 0.03    | 0.02    | 0.02   |

259 † Mob 2 yrs measurements for Fall '12 and Spring '13 are pooled data from Mob 1 year and Mob 2 year plots as treatments

260 were identical during the first year of study. Fall 2013 measurements are separated with "Mob 1yr, Rotational" representing a

261 rotational grazing treatment following one year of Mob Grazing and "Mob 2yr" representing two consecutive years of Mob

262 Grazing

**Table 2.** Effects of four grazing treatments on forage biomass production, forage utilization, and percent utilization in temperate pastures at Hollandale, WI in 2012. Treatments evaluated include 1) an herbicide application followed by rotational grazing for one year (H-Rgraze), 2) rotational grazing for one year (Rgraze), and 3) Mob grazing for one year (Mob). Treatments were replicated four times at each site. Letter codes indicate significance of pairwise tests within columns.

| 2012 forage productivity and utilization |                          |        |       |       |         |                         |        |       |       |       |               |            |
|--|--------------------------|--------|-------|-------|---------|-------------------------|--------|-------|-------|-------|---------------|------------|
| Treatment                                | Forage available (kg/ha) |        |       |       |         | Forage utilized (kg/ha) |        |       |       |       | % utilization |            |
|  | Grass                    | Clover | CT    | Other | Total   | Grass                   | Clover | CT    | Other | Total | Total         | C. thistle |
| H-Rgraze                                 | 3701 a                   | 0‡     | 51 b  | 146 b | 3898 b  | 2738 a                  | 0‡     | 30 b  | 136 b | 2903  | 76 a          | 43         |
| Mob§                                     | 2793 b                   | 1896 a | 595 a | 525 a | 5809 a  | 994 b                   | 1365   | 266 a | 378 a | 3002  | 51 b          | 47         |
| Rgraze                                   | 3335 ab                  | 684 b  | 461 a | 627 a | 5106 ab | 2292 a                  | 548    | 299 a | 364 a | 3503  | 69 a          | 65         |
| p-value                                  | 0.09                     | 0.09   | <0.01 | <0.01 | 0.06    | <0.01                   | NS     | <0.01 | 0.02  | NS    | <0.01         | NS         |

‡Not included in the ANOVA statement as no variability was present

§Pooled Mob 1 year and Mob 2 year treatments as protocols were identical the first year of study.

**Table 3.** Effects of four grazing treatments on forage biomass production, forage utilization, and percent utilization in temperate pastures at Hollandale, WI in 2013. Treatments evaluated include 1) an herbicide application followed by rotational grazing for two years (H-Rgraze 2 yrs), 2) rotational grazing for two years (Rgraze 2 yrs), 3) Mob grazing for one year followed by one year of rotational grazing (Mob/Rgraze) and 4) Mob grazing for two years (Mob 2 yrs). Treatments were replicated four times at each site. Letter codes indicate significance of pairwise tests within columns.

| 2013 forage productivity and utilization |                          |        |        |        |         |                         |        |     |        |       |               |            |
|--|--------------------------|--------|--------|--------|---------|-------------------------|--------|-----|--------|-------|---------------|------------|
| Treatment                                | Forage available (kg/ha) |        |        |        |         | Forage utilized (kg/ha) |        |     |        |       | % utilization |            |
|  | Grass                    | Clover | CT     | Other  | Total   | Grass                   | Clover | CT  | Other  | Total | Total         | C. thistle |
| H-Rgraze 2 yrs                           | 6827                     | 9 b    | 241 b  | 111 b  | 7188 ab | 4608                    | 6 b    | 91  | 73 b   | 4778  | 67 a          | 38         |
| Mob/Rgraze                               | 6619                     | 132 b  | 405 b  | 257 ab | 7415 ab | 4500                    | 103 b  | 220 | 206 ab | 5030  | 68 a          | 49         |
| Mob 2 yrs                                | 7426                     | 68 b   | 1196 a | 470 a  | 9160 a  | 3734                    | 55 b   | 478 | 402 a  | 4669  | 51 b          | 37         |
| Rgraze 2 yrs                             | 5604                     | 699 a  | 328 b  | 413 ab | 7045 b  | 3342                    | 540 a  | 150 | 311 ab | 4344  | 61 a          | 43         |
| p-value                                  | NS                       | <0.01  | <0.01  | 0.07   | 0.08    | NS                      | <0.01  | NS  | 0.07   | NS    | <0.01         | NS         |

**Table 4..** Effects of four grazing treatments on forage biomass production, forage utilization, and percent utilization in temperate pastures at Prairie Du Sac, WI in 2012. Treatments evaluated include 1) an herbicide application followed by rotational grazing for one year (H-Rgraze), 2) rotational grazing for one year (Rgraze), and 3) Mob grazing for one year (Mob). Treatments were replicated four times at each site. Letter codes indicate significance of pairwise tests within columns.

| 2012 forage productivity and utilization |                          |        |       |       |        |                         |        |       |       |        |               |            |
|--|--------------------------|--------|-------|-------|--------|-------------------------|--------|-------|-------|--------|---------------|------------|
| Treatment                                | Forage available (kg/ha) |        |       |       |        | Forage utilized (kg/ha) |        |       |       |        | % Utilization |            |
|  | Grass                    | Clover | CT    | Other | Total  | Grass                   | Clover | CT    | Other | Total  | Total         | C. thistle |
| H-Rgraze                                 | 2840 ab                  | 1      | 24 c  | 217 b | 3081 b | 2205                    | 1      | 19 b  | 145   | 2368 b | 76 ab         | 79 ab      |
| Mob <sup>§</sup>                         | 3538 a                   | 48     | 321 a | 616 a | 4524 a | 2981                    | 42     | 278 a | 534   | 3748 a | 83 a          | 88 a       |
| Rgraze                                   | 2727 b                   | 26     | 129 b | 829 a | 3710 b | 1983                    | 25     | 52 b  | 429   | 2485 b | 67 b          | 40 b       |
| p-value                                  | 0.06                     | NS     | <0.01 | 0.03  | <0.01  | NS                      | NS     | <0.01 | NS    | <0.01  | 0.06          | 0.04       |

<sup>§</sup>Pooled Mob 1 year and Mob 2 year treatments as protocols were identical the first year of study.

**Table 5.** Effects of four grazing treatments on forage biomass production, forage utilization, and percent utilization in temperate pastures at Prairie Du Sac, WI in 2013. Treatments evaluated include 1) an herbicide application followed by rotational grazing for two years (H-Rgraze 2 yrs), 2) rotational grazing for two years (Rgraze 2 yrs), 3) Mob grazing for one year followed by one year of rotational grazing (Mob/Rgraze) and 4) Mob grazing for two years (Mob 2 yrs). Treatments were replicated four times at each site. Letter codes indicate significance of pairwise tests within columns.

| 2013 forage productivity and utilization |                          |        |        |       |        |                         |        |       |       |        |               |            |
|--|--------------------------|--------|--------|-------|--------|-------------------------|--------|-------|-------|--------|---------------|------------|
| Treatment                                | Forage available (kg/ha) |        |        |       |        | Forage utilized (kg/ha) |        |       |       |        | % Utilization |            |
|  | Grass                    | Clover | CT     | Other | Total  | Grass                   | Clover | CT    | Other | Total  | Total         | C. thistle |
| H-Rgraze 2 yrs                           | 4808 b                   | 13 ab  | 47 c   | 163   | 5031 b | 2921 b                  | 13     | 28 b  | 99    | 3056 b | 62 ab         | 40 ab      |
| Mob/Rgraze                               | 4651 b                   | 19 ab  | 254 b  | 463   | 4787 b | 2683 b                  | 15     | 78 b  | 425   | 3200 b | 67 ab         | 43 ab      |
| Mob 2 yrs                                | 7603 a                   | 2 b    | 580 a  | 183   | 8368 a | 5869 a                  | 2      | 504 a | 168   | 6543 a | 79 a          | 87 a       |
| Rgraze 2 yrs                             | 4403 b                   | 34 a   | 109 bc | 220   | 4766 b | 2474 b                  | 31     | 41 b  | 89    | 2612 b | 55 b          | 29 b       |
| p-value                                  | <0.01                    | 0.09   | <0.01  | NS    | <0.01  | <0.01                   | NS     | <0.01 | NS    | <0.01  | 0.03          | 0.10       |

**Table 6.** Effects of four grazing treatments on forage biomass production, forage utilization, and percent utilization in temperate pastures at Lancaster, WI in 2012. Treatments evaluated include 1) an herbicide application followed by rotational grazing for one year (H-Rgraze), 2) rotational grazing for one year (Rgraze), and 3) Mob grazing for one year (Mob). Treatments were replicated four times at each site. Letter codes indicate significance of pairwise tests within columns.

| 2012 forage productivity and utilization |                          |        |      |       |         |                         |        |      |       |         |               |            |
|--|--------------------------|--------|------|-------|---------|-------------------------|--------|------|-------|---------|---------------|------------|
| Treatment                                | Forage available (kg/ha) |        |      |       |         | Forage utilized (kg/ha) |        |      |       |         | % Utilization |            |
|  | Grass                    | Clover | CT   | Other | Total   | Grass                   | Clover | CT   | Other | Total   | Total         | C. thistle |
| H-Rgraze                                 | 6250                     | 79 c   | 0‡   | 22 b  | 6357 b  | 4921 a                  | 76 c   | 0‡   | 12 b  | 4995 ab | 80 a          | 0‡         |
| Mob§                                     | 7612                     | 1320 b | 1642 | 68 b  | 10618 a | 2681 b                  | 924 b  | 1058 | 67 ab | 4921 b  | 46 c          | 68 a       |
| Rgraze                                   | 6364                     | 1945 a | 1793 | 213 a | 10314 a | 4020 ab                 | 1502 a | 581  | 182 a | 6285 a  | 61 b          | 41 b       |
| p-value                                  | NS                       | <0.01  | NS   | 0.01  | <0.01   | 0.02                    | <0.01  | NS   | 0.06  | 0.09    | <0.01         | 0.03       |

‡Not included in the ANOVA statement as no variability was present

§Pooled Mob 1 year and Mob 2 year treatments as protocols were identical the first year of study.

**Table 7.** Effects of four grazing treatments on forage biomass production, forage utilization, and percent utilization in temperate pastures at Lancaster, WI in 2013. Treatments evaluated include 1) an herbicide application followed by rotational grazing for two years (H-Rgraze 2 yrs), 2) rotational grazing for two years (Rgraze 2 yrs), 3) Mob grazing for one year followed by one year of rotational grazing (Mob/Rgraze) and 4) Mob grazing for two years (Mob 2 yrs). Treatments were replicated four times at each site. Letter codes indicate significance of pairwise tests within columns.

| 2013 forage productivity and utilization |                          |        |        |       |         |                         |        |        |       |         |               |            |
|--|--------------------------|--------|--------|-------|---------|-------------------------|--------|--------|-------|---------|---------------|------------|
| Treatment                                | Forage available (kg/ha) |        |        |       |         | Forage utilized (kg/ha) |        |        |       |         | % Utilization |            |
|  | Grass                    | Clover | CT     | Other | Total   | Grass                   | Clover | CT     | Other | Total   | Total         | C. thistle |
| H-Rgraze 2 yrs                           | 6914 b                   | 559 c  | 85 b   | 105   | 7662 c  | 4308 a                  | 473 b  | 12 b   | 62    | 4781 b  | 62            | 14 b       |
| Mob/Rgraze                               | 4799 c                   | 2988 a | 1384 a | 235   | 9405 bc | 2860 b                  | 2020 a | 249 b  | 111   | 5144 b  | 54            | 18 b       |
| Mob 2 yrs                                | 8454 a                   | 1400 b | 2734 a | 159   | 12747 a | 4287 a                  | 1031 b | 1827 a | 158   | 7303 a  | 57            | 68 a       |
| Rgraze 2 yrs                             | 4999 c                   | 3184 a | 1739 a | 351   | 10272 b | 3005 b                  | 2280 a | 629 ab | 261   | 6176 ab | 60            | 35 ab      |
| p-value                                  | <0.01                    | <0.01  | <0.01  | NS    | <0.01   | 0.01                    | <0.01  | <0.01  | NS    | 0.04    | NS            | <0.01      |

## Chapter 2

### Defining Mob Grazing in the Upper Midwestern United States

#### Abstract

Mob grazing has emerged as an increasingly used management strategy on pasture-based farms throughout the Midwestern United States. Although it has been the subject of numerous producer discussions and popular articles, the practice lacks clear definition. We conducted a survey of livestock (beef) and dairy producers using rotational grazing in the upper Midwestern United States (n=155) to gather information about how they define mob grazing, what the perceived benefits and disadvantages are, and if they use mob grazing, what its application looks like at the farm-scale. The five components most commonly used to define mob grazing were increased stocking density, increased rest periods, trampled forage, shortened grazing periods, and grazing mature forage. Respondents viewed even distribution of nutrients, decreased selectivity, increased organic matter, weed control, and resilience as benefits of mob grazing. Disadvantages included increased labor and time, decreased forage quality, and limited applicability in some environments. We found pronounced variability in the practices of the 58 self-identified mob graziers surveyed. The majority (60%) stock between 56,000 and 280,210 kg live weight ha<sup>-1</sup>, rotate their herds one to three times per day (84%), and rest their paddocks between 31 and 60 days (71%), while half employ mob grazing for the majority of the season. Given the limitless variations of mob grazing on the landscape, we recommend that researchers carefully describe all elements of any grazing system

being studied, including stocking density, length of rest and grazing periods, and degree of forage trample (all defining elements selected by >50% of respondents) to increase the utility of conclusions.

## **Introduction**

Interest in mob grazing is increasing in the upper Midwestern region of the United States. While practiced in various forms by growers, this method of grazing is poorly defined and its source unclear. Some believe that the term originated when the forage researcher, G. O. Mott returned from Australia, where herds are sometimes referred to as “mobs”, and applied the expression to the new defoliation technique he and a team were pioneering. Researchers working with G. O. Mott described and implemented strategic high intensity grazing as early as 1982 in forage evaluation trials studying animal impact and selectivity (Mislevy 1982). They describe mob grazing as a “defoliation technique which simulates intensive rotational grazing” and is typified by “a high stocking density on a limited land area for a short period of time.” (Gildersleeve et al. 1987). Others believe it arose with farmers adapting their herd management strategies to mimic natural herbivore behavior, including higher stocking densities, shorter grazing events, and longer rest periods (Savory 1978). However the term arose, its history since the practice’s advent has been equally uncertain.

Only recently has mob grazing, sometimes referred to as ultra-high stocking density, become a widely used term among producers and in farmer-focused industry publications (Thomas 2012; Holin 2013; Kidwell 2012; Hafla et al. 2014).

The re-emergence of mob grazing in popular press articles and at pasture walks and conferences throughout the world appears to be producer-generated (Thomas 2012), and though practices are similar to those described by Gildersleeve et al. (1987), the current form seems to include a broader management system extending beyond the use of increased stocking density as a defoliation technique. While the International Forage and Grazing Terminology Committee does not include mob grazing as official terminology, they define mob stocking as “A method of stocking at a high grazing pressure for a short time to remove forage rapidly as a management strategy” (Allen et al 2011). This definition, while helpful, lacks details necessary to implement this practice in a consistent manner.

Also important to note are grazing practices that share management elements with mob grazing, including holistic management (Savory 1978; Butterfield et al. 2006) and high intensity-low frequency grazing (HILF)(Allen et al. 2011; De Bruijn and Bork 2006)). Holistic management lacks a clear definition and can be thought of as a philosophy that includes rotational grazing at higher stocking densities, while HILF is clearly defined as a rotational grazing system that employs high to medium stocking densities on 3–5 pasture units with grazing periods generally over 2 weeks and two to four grazing periods per year (Allen et al. 2011). Although mob grazing seems to be derivative of HILF and Holistic management, it does not appear to be synonymous.

The scientific community has conducted limited research on mob grazing, and none focusing on its use as a production practice. We are aware of no studies published with respect to mob grazing’s application on the landscape. The few

studies that exist have used research trials or case studies of self-identified mob graziers or producers using ultra high stocking densities and have attempted to quantify the practice's effect on soil parameters, forage utilization, forage quality, and weed presence (Russell 2010; Hafla et al. 2014). These contributions are important additions to the emerging study of mob grazing. What has become clear, however, is that there is pronounced variation in how producers utilize mob grazing and, therefore, how researchers are exploring the practice. For instance, Hafla et al. (2014) found that among four northeastern producers using mob grazing, stocking densities ranged from 49,421 to 377,912 kg ha<sup>-1</sup>, the lower density falling within the regularly identified range for rotational grazing.

It is clear that the term mob grazing has gained its largest audience, adoption, and number of detractors to date, suggesting the need for the development of a detailed definition. To better understand this re-emerging grazing practice, an attempt should be made to develop a clear description that allows for standardization across experiments to ensure that contributions are comparable to what practitioners are doing on the landscape. To this end, we conducted a survey of livestock and dairy producers using rotational grazing in the upper Midwestern United States. We sought to gather information about how producers define mob grazing, what they perceive the benefits and drawbacks to be, and if they use mob grazing, what its application looks like at the farm-scale.

## Survey methods and analysis

We conducted a survey from March to October, 2013, targeting producers who use some form of rotational grazing on cool-season pastures and reside in Wisconsin, Illinois, Iowa, or Minnesota. A link to the survey (Appendix A) was distributed at grazing conferences, through grazing networks, producer meetings, and personal email correspondence. The link contained directions and approvals as dictated by the Social and Behavioral Science Internal Review Board at UW-Madison and results were collected using the online survey tool Qualtrics (Version 56038, 2009, Qualtrics). Due to the broad distribution of the survey and utilization of multiple networks, it is difficult to estimate the exact number of surveys distributed or a resulting return rate. Our best estimate is that approximately 400 potential respondents were reached, with a 39% return rate. Survey questions were designed to address 1) the respondent's perception, definition, and identified benefits and drawbacks of mob grazing, 2) sources of information used by respondents to educate themselves about mob grazing, and 3) the management practices of respondent's using mob grazing.

Respondents were separated into livestock (beef) versus dairy producers and practicing versus non-practicing mob graziers to analyze the differences in responses to select questions using the chi-square test. Differences were considered statistically significant at  $P < 0.10$ . All data analysis was performed using the statistical software R (Version 3.0.2, 2013, R Core Development Team).

## Description of respondents

Approximately 400 surveys were distributed to potential respondents, and 155 completed surveys were received. The majority of respondents were from Wisconsin (66%), with an equal number from Minnesota and Iowa (14%), and the least from Illinois (9%). There are many possible explanations for this unequal geographic distribution. Most agricultural networks are necessarily place-based, and as this study was conducted at the University of Wisconsin-Madison, the networks of producers that we had access to were primarily from Wisconsin. Additionally, Wisconsin has the largest number of farms using managed grazing among the states where the survey was distributed, though only by a small margin (USDA NASS 2007). Lastly, due to the long history of farmer networks in Wisconsin that allow for the informal and free transfer of information, the survey may have benefited from well-connected producers (Hassanein and Kloppenburg 1995).

Most operations raised cattle (81%), but sheep (12%) and goats (3%) were also identified. Seventy four percent of all respondents described themselves as livestock operations while 27% identified themselves as dairy. Results from a larger survey of Wisconsin graziers (n=7833) found a more even distribution between livestock and dairy operations that use rotational grazing, with 61% livestock and 39% dairy (Paine and Gildersleeve 2011). This suggests we received a lower response from dairy operations than livestock and may, therefore, under-represent this population and over-represent livestock producers.

Paine and Gildersleeve (2011) also identified mob grazing as a “relatively new practice in Wisconsin, involving very high stocking densities for short periods

of four to six hours” and found that 25% of beef producers and 29% of dairy producers use the practice (Paine and Gildersleeve 2011). We found a similar pattern with 37% of beef producers and 40% of dairy producers using mob grazing. It’s likely that our sample under-represents both groups while over- representing those who may be early adopters of new practices or well-connected farmers with increased access to information and resources. We found that 37% (n=56) of our survey’s respondents use mob grazing, with 29% from dairy and 71% from livestock operations.

### **Definitions, benefits, and drawbacks**

As mob grazing lacks a universal definition, we collected commonly used descriptions for mob grazing from available publications, personal correspondence, and conference presentations. We narrowed this list to ten potential definitions and asked producers to choose the five that most closely aligned with their own definition of mob grazing (Table 1). The five most indicated components were increased stocking density, increased rest periods, trampled forage, shortened grazing periods, and grazing mature forage. Although the ranking was not the same between mob and rotational graziers, each group had the same responses within the top five ranked elements. More mob graziers than rotational graziers indicated that an increase in rest period length was a defining practice (chi-square=7.05, df=1, p-value<0.01). Rest periods are often emphasized by practitioners as an overlooked element of mob grazed systems (Thomas 2012).

There are numerous purported benefits that result from implementing mob grazing, though none have been documented by research to date. We collected the most commonly claimed positive results (11) and asked respondents to choose five (Table 2). The five highest-ranked potential benefits were even distribution of nutrients, decreased selectivity, increased soil organic matter, weed control, and pasture resilience. These top five benefits were ranked the same between mob and non-mob graziers with no differences observed between both groups. Lower ranking benefits (<30%) did, however, differ between groups. More mob graziers identified increased profitability ( $p < 0.01$ ), increased forage amount ( $p = 0.07$ ), and animal health ( $p < 0.01$ ) as benefits than producers not using mob grazing. These differences highlight often-held reservations about the practice, namely that profitability may be reduced by trampling forage and animal health can be negatively affected by increasing stocking density and grazing mature forage. That mob graziers label these as benefits indicates that reservations among those not using mob grazing may be unfounded or informed primarily by specific operation type or location.

Just as unsubstantiated claims about mob grazing's benefits abound, so too do equally untested disadvantages. We identified 11 of the most commonly mentioned disadvantages and instructed farmers to choose five (Table 3). Both groups indicated that increased labor and time were mob grazing's largest drawbacks although 28% fewer dairy producers saw increased time as a disadvantage (Chi-square = 12.03,  $df = 2$ ,  $p\text{-value} < 0.01$ ) (data not shown). This is likely explained by the daily herd moves that typically take place on many rotational

dairy operations, suggesting that dairies may be uniquely suited to adapt their grazing systems to the constant rotations indicative of mob grazing. Further supporting this observation is that 95% of all dairy-farming respondents are full-time producers, while only 55% of beef producers farm full time.

The third most commonly indicated disadvantage was reduced forage nutritive value. Sixteen percent fewer mob than non-mob practitioners identified a decrease in forage quality as a disadvantage, addressing a common hesitation pertaining to reduced forage quality held by dairy producers. That being said, among producers actually using mob grazing, more dairy (31%) than livestock farmers (12%) saw reduced forage quality as a disadvantage ( $\chi^2=5.68$ ,  $df=2$ ,  $p=0.06$ ) (data not shown). The limited applicability of mob grazing to many environments was the fourth most cited disadvantage, though fewer mob graziers (14%) held this opinion than rotational graziers (30%) ( $\chi^2 = 4.02$ ,  $df = 1$ ,  $p\text{-value} = 0.04$ ). Another identified disadvantage was that mob grazing only works with some animals. Not surprisingly, dairy producers were more concerned than beef producers about animal applicability ( $\chi^2 = 15.6028$ ,  $df = 2$ ,  $p\text{-value} = 0.0004$ ) (data not shown). Among mob graziers, however, there was no difference between dairy and livestock producers pertaining to mob grazing's applicability to animal type, suggesting that some farmers have found mob grazing to be an appropriate strategy for many types of livestock. However, most dairy producers are far more likely to mob graze heifers and dry cows than their milking herd (personal communication, Cheyenne Christianson). Finally, 13% more mob graziers

thought that none of the potential disadvantages applied, indicating satisfaction among many practitioners of mob grazing (chi-square=5.95, df=1, p=0.01).

### **Information distribution**

Respondents indicated that they received the most information about mob grazing at conferences and from other farmers, although industry publications, government agency and industry personnel, and extension publications were also reported as common sources (Table 4). Given Hassanein and Kloppenburg's (1995) observation that "graziers produce and transmit knowledge themselves...through horizontal information exchange," our findings are not surprising. Industry publications were the largest source of written information (45%) with other sources identified by 14-23% respondents. Across all publications, an average 26% of respondents found information online while 56% read about mob grazing in print sources and 18% utilized both online and print resources. This indicates that although computer use continues to rise in the upper Midwest (Batte 2005), producers may still prefer sources of information available in print to those found on the Internet.

Producers were also asked which of the eight information sources previously identified would have the greatest impact on their adoption of the practice. The only two categories to increase in relation to identified information source were "other farmers" and "scientific articles" while selection of other sources was either unchanged or reduced (Table 4). Both industry contacts and industry publications decreased by >50%. These results further support the importance of farmer-to-

farmer information exchange within the grazing community. They also indicate that though industry publications and contacts effectively extend information, the impact of this content is less than might be assumed given the scale of coverage.

### **Perceptions of mob grazing**

A primary objective of the survey was to assess farmer perceptions of mob grazing. We first looked at how information sources portrayed mob grazing on a scale from extremely negative to extremely positive. We then asked for producer's personal opinions about mob grazing on the same scale. The majority (93%) of all respondents indicated that the practice was portrayed as somewhat to extremely positive in the information sources they accessed while only 4% had seen a somewhat to extremely negative portrayal (table 5). However, personal opinions differed from those represented by authors and speakers providing information about mob grazing. Many (71%) indicated that they had a somewhat to extremely positive opinion about the practice, while 10% had a somewhat to extremely negative opinion. Perhaps the most notable departure between the two questions was the increase from 3% to 19% of those indicating a neutral opinion. Personal opinion also differed between graziers using mob grazing and those not. Not surprisingly, more producers using mob grazing have a positive opinion of the practice (91%) than rotational graziers not mob grazing (58%) (Chi-squared=40.9, df=7, p-value <0.01). Of the respondents with neutral opinions, few were active mob graziers, indicating many rotational graziers had not yet formed an opinion about this practice. Results suggest a clear disconnect between how advocates are

portraying mob grazing and what producer's opinions are. Further, those who have used mob grazing hold overwhelmingly positive opinions of the management strategy while rotational graziers appear more hesitant to embrace it.

### **A Midwestern mob grazer**

Our audit of 58 Midwestern producers who use mob grazing found pronounced variability in their practices. When asked what percentage of the growing season producers utilize mob grazing, we found 51% of the respondents were using this practice for the majority of the growing season (table 6). In contrast, many are using this practice much less frequently, with 30% mob grazing for less than 50% of the year. This suggests many others are using this practice strategically. A deliberate deployment of mob grazing may be used for any number of reasons including rapid defoliation during the spring flush, giving an overgrazed pasture a longer rest period, improving manure distribution, or a desire to increase utilization of an otherwise refused forage.

Herd size also varied greatly, with many producers raising less than 25 animals (12%) a few managing over 400 (5%), and the vast majority (78%) having moderately-sized herds of 26-200 animals. There is a commonly held sentiment that a producer needs to have a very large herd to effectively mob graze. Our results suggest that this is not the case. Average stocking densities also ranged widely, varying from less than 56,000 kg ha<sup>-1</sup> to nearly 1,120,000 kg ha<sup>-1</sup>, with more than half (60%) of the mob graziers surveyed stocking between 56,000 and 280,210 kg live weight ha<sup>-1</sup>. While we documented some producers stocking over 560,425 kg

ha<sup>-1</sup>, this was a much lower percentage than expected and in agreement with other case studies (Hafla et al. 2014).

Pastures grazed by both dairy and beef herds were rotated with the same regularity when employing mob grazing. The majority of respondents (84%) moved one to three times a day with no respondent moving more than five times in one day. After a grazing event, less than four to more than ten inches of residue was left, though a common residual fell between four and seven inches (76%). Dairy producers grazed pastures lower than livestock producers, with 88% of dairymen leaving less than five inches and 44% of beef graziers leaving six or more inches (Chi-square=19.44, df=6, p<0.01) (data not shown). Paddocks were rested from 20 to 80+ days with 71% of respondents falling between 31 and 60 days (data not shown).

While a goal of our survey was to develop a user-defined definition of typical mob grazing practices in the upper-Midwest, the results suggest that this practice is, by definition, variable. Typical suggested definitions include a high stocking density, short grazing intervals, and long rest periods. We found that while respondents agree that these were important in defining mob grazing, implementation of these practices by respondents varied widely, making it difficult to describe the practice in definitive terms. Given the limitless variations of mob grazing on the landscape, we recommend that researchers carefully describe all elements of any grazing system being studied, including stocking density, length of rest and grazing periods, and degree of forage trample (all defining elements selected by >50% of respondents) to increase the utility of conclusions. Unpredictable weather, markets, and animals

dictate that flexibility is built into any pasture-based, management-intensive farming system, though it's likely that mob grazing demands a more elastic management strategy than typical rotational grazing. Further, the differences between typical rotational and mob grazing management will surely influence the potential agronomic and environmental impacts. Although the advantages and disadvantages of mob grazing have not been borne out by research or universally experienced by producers, our findings indicate that producers are strategically and adaptively applying this emerging management tool.

## **References**

Allen, V. G., C. Batello, E. J. Berretta, J. Hodgson, M. Kothmann, X. Li, J. McIvor, J. Milne, C. Morris, A. Peeters, and M. Sanderson. 2011. An international terminology for grazing lands and grazing animals. *Grass and Forage Science*, 66: 2-28.

Batte, M. T. 2005. Changing computer use in agriculture: evidence from Ohio. *Computers and Electronics in Agriculture* 38: 125-139.

Butterfield, J., S. Bingham, A. Savory. 2006. *Holistic management handbook: healthy land, healthy profits*. Island Press, Washington DC.

S. De Bruijn & E Bork. 2006. "Biological control of Canada thistle in temperate pastures using high density rotational cattle grazing." *Biological Control*, 36:305-315.

Gildersleeve, R.R., W. R. Ocumpaugh, K. H. Quesenberry, and J. E. Moore. 1987. Mob-grazing of morphologically different *Aeschynomene* species. *Tropical Grasslands* 21: 123-132.

Hafla, A. N., K. J. Soder, M. Hautau, M. D. Rubano, B. Moyer and R. Stout. 2014. Case Study: Dairies using self-described ultra-high stocking density grazing in Pennsylvania and New York. *Professional Animal Scientist*, 30: 366-374.

Hassanein, N. and J. R. Kloppenburg. 1995. Where the grass grows again: knowledge exchange in the sustainable agriculture movement. *Rural Sociology* 60: 721-740.

Holin, F. 2013. Mob grazing: a tool, not a master plan. *Hay & Forage Grower*, August 12, 2013.

Kidwell, B. (2010, March). Mob grazing. *Angus Beef Bulletin*, Retrieved from [http://www.angusbeefbulletin.com/ArticlePDF/MobGrazing\\_03\\_10\\_ABB.pdf](http://www.angusbeefbulletin.com/ArticlePDF/MobGrazing_03_10_ABB.pdf)  
Accessed March 23, 2013.

Mislevy, P., G. O. Mott, and F. G. Martin. 1982. Screening perennial forages by mob-grazing technique. Proc. 14<sup>th</sup> Int. Grassld. Congr., Lexington, KY. Pp. 516-519.

USDA National Agricultural Statistics Service. 2007. Census of Agriculture.

[http://www.agcensus.usda.gov/Publications/2007/Full\\_Report/Volume\\_1,\\_Chapter\\_2\\_US\\_State\\_Level/st99\\_2\\_044\\_044.pdf](http://www.agcensus.usda.gov/Publications/2007/Full_Report/Volume_1,_Chapter_2_US_State_Level/st99_2_044_044.pdf)

Paine, L., and R. Gildersleeve. 2011. A summary of dairy grazing practices in Wisconsin. Wisconsin Department of Agriculture, Trade, and Consumer Protection. <http://datcp.wi.gov/uploads/Farms/pdf/2011DairyGrazingSummary.pdf>. Accessed February 1, 2014.

Paine, L., and R. Gildersleeve. 2011. A summary of beef grazing practices in Wisconsin. University of Wisconsin Extension. <http://fyi.uwex.edu/grazres/files/2011/05/2011-Beef-Grazing-Summary-FINAL.pdf>. Accessed February 1, 2014.

Russell, J. (2010). Use of mob grazing to improve calf production, enhance legume establishment, and increase carbon sequestration in iowa pastures. Retrieved from <http://www.leopold.iastate.edu/grants/e2010-13> Accessed April 14, 2014.

Savory, A. 1978. A holistic approach to range management using short duration grazing. Proc. Intn'l. Rangel. Congr. 1 :555-557.

Thomas, H. S. 2012. Ranchers sing the praises of mob grazing of cattle. Beef.

<http://beefmagazine.com/pasture-range/ranchers-sing-praises-mob-grazing-cattle?page=1> DATE ASSESSED??????

**Table 1.** Defining mob grazing in the upper Midwestern United States. Producers were given 10 partial definitions selected from available publications, personal correspondence, and conference presentations and asked to select the top 5 that define mob grazing. Producers who use mob grazing and those who don't (rotational graziers) are presented in separate columns.

| <b>Mob graziers</b>        | <b>Mob graziers<br/>(n=58)</b> | <b>P value</b> | <b>Rotational graziers<br/>(n=97)</b> |
|----------------------------|--------------------------------|----------------|---------------------------------------|
| Increased stocking density | 79%                            | NS             | 88%                                   |
| Increased rest period†     | 76%                            | <b>0.008</b>   | 55%                                   |
| Trampled forage            | 62%                            | NS             | 60%                                   |
| Shortened grazing period   | 60%                            | NS             | 59%                                   |
| Grazing mature forage      | 36%                            | NS             | 34%                                   |
| Leaving forage uneaten     | 31%                            | NS             | 24%                                   |
| The 'herd' effect          | 31%                            | NS             | 28%                                   |
| Increased stocking rate    | 26%                            | NS             | 33%                                   |

---

|                    |     |    |     |
|--------------------|-----|----|-----|
| Constant moves     | 16% | NS | 28% |
| Increased residual | 5%  | NS | 14% |
| None of these      | 0%  | NS | 1%  |
| Other              | 0%  | NS | 2%  |

---

† chi-square= 7.05, df=1, p-value= 0.008

**Table 2.** Perceived benefits of mob grazing pastures in the upper Midwestern United States. Producers were given 13 potential benefits of mob grazing selected from available publications, personal correspondence, and conference presentations and asked to select the top 5 most important to them. Producers who use mob grazing and those who don't (rotational graziers) are presented in separate columns.

| <b>Potential benefits</b>               | <b>Mob graziers<br/>(n=58)</b> | <b>P value</b> | <b>Rotational graziers<br/>(n=97)</b> |
|---|--------------------------------|----------------|---------------------------------------|
| Even distribution of nutrients          | 67%                            | NS             | 60%                                   |
| Decreased selectivity                   | 60%                            | NS             | 56%                                   |
| Increased organic matter                | 45%                            | NS             | 46%                                   |
| Weed control                            | 36%                            | NS             | 38%                                   |
| Resilience                              | 36%                            | NS             | 30%                                   |
| Increased soil moisture                 | 28%                            | NS             | 27%                                   |
| Ability to increase number of animals   | 22%                            | NS             | 27%                                   |
| Increased forage diversity              | 21%                            | NS             | 24%                                   |
| Increased production (meat and/or milk) | 22%                            | NS             | 15%                                   |

---

|                          |     |              |     |
|--------------------------|-----|--------------|-----|
| Increased profitability‡ | 26% | <b>0.01</b>  | 9%  |
| Increased forage amount§ | 22% | <b>0.07</b>  | 11% |
| Season extension         | 19% | NS           | 11% |
| Animal health¶           | 22% | <b>0.001</b> | 3%  |
| Other                    | 12% | NS           | 3%  |
| None of these            | 0%  | NS           | 1%  |

---

† X-squared = 6.2399, df = 1, p-value = 0.012

‡ X-squared = 3.1815, df = 1, p-value = 0.074

§ X-squared = 10.7347, df = 1, p-value = 0.001

**Table 3.** Perceived disadvantages of mob grazing pastures in the upper Midwestern United States. Producers were given 11 potential disadvantages of mob grazing selected from available publications, personal correspondence, and conference presentations and asked to select the top 5 most serious drawbacks. Producers who use mob grazing and those who don't (rotational graziers) are presented in separate columns.

| Potential disadvantages                | Mob graziers<br>(n=58) | P value     | Rotational graziers<br>(n=97) |
|--|------------------------|-------------|-------------------------------|
| Increased labor                        | 52%                    | NS          | 59%                           |
| Increased time                         | 28%                    | NS          | 41%                           |
| Decreased forage quality †             | 17%                    | <b>0.08</b> | 33%                           |
| Only applicable in some environments ‡ | 14%                    | <b>0.04</b> | 30%                           |
| Increased soil compaction              | 19%                    | NS          | 25%                           |
| Only works with some animals           | 19%                    | NS          | 24%                           |
| Decreased production                   | 9%                     | NS          | 20%                           |
| Decreased animal health                | 17%                    | NS          | 8%                            |
| Decreased soil quality                 | 2%                     | NS          | 7%                            |

---

|                          |     |             |     |
|--------------------------|-----|-------------|-----|
| Increased soil erosion § | 2%  | <b>0.09</b> | 10% |
| Decreased profit         | 3%  | NS          | 7%  |
| None of these ¶          | 17% | <b>0.01</b> | 4%  |
| Other                    | 10% | NS          | 8%  |

---

† X-squared = 3.0615, df = 1, p-value = 0.08017

‡ X-squared = 4.0203, df = 1, p-value = 0.04495

§ X-squared = 2.9353, df = 1, p-value = 0.08666

¶ X-squared = 5.9528, df = 1, p-value = 0.01469

**Table 4.** Sources of information about mob grazing and their impact as identified by producers using rotational grazing in the upper Midwestern United States. Producers were asked to indicate what sources of information they've sought to educate themselves about mob grazing, as well as which source would have the greatest impact on adoption of the practice.

| <b>Source</b>            | <b>Where have you received information about Mob grazing? (n=148)</b> | <b>What would have the greatest impact on your adoption of Mob grazing? (n=142)</b> |
|--------------------------|---|---|
| Conference               | 67%   | 42%   |
| Other farmers            | 66%   | 72%   |
| Industry publication     | 45%   | 17%   |
| Industry contact         | 30%   | 14%   |
| Government agency person | 30%   | 19%   |
| Extension publication    | 23%   | 23%   |
| Nonprofit publication    | 16%   | 12%   |
| Scientific publication   | 14%   | 19%   |

**Table 5.** Opinions about mob grazing, both in sources of information and personal opinions. Producers were asked 1.) How mob grazing has been portrayed in the information they've seen and 2.) What their personal opinion about mob grazing is.

|                    | <b>Information source</b> | <b>Personal</b> |
|--------------------|---------------------------|-----------------|
| Extremely positive | 18%                       | 16%             |
| Very positive      | 44%                       | 23%             |
| Somewhat positive  | 31%                       | 32%             |
| Neutral            | 3%                        | 19%             |
| Somewhat negative  | 3%                        | 7%              |
| Very negative      | 1%                        | 2%              |
| Extremely negative | 0%                        | 1%              |

**Table 6.** Seasonality of mob grazing use among self-identified mob graziers. Producers were asked for what percent of the growing season they utilize mob grazing.

| <b>Percent of growing season</b> | <b>Percent of respondents who use mob grazing for specified duration</b> |
|----------------------------------|--|
| 0-25%                            | 25%  |
| 25-50%                           | 5%   |
| 51-75%                           | 19%  |
| 76-100%                          | 51%  |



## Appendix A.

Where is your operation located?

---

Wisconsin       Minnesota       Iowa       Illinois       Other:

---

What type of grazing operation do you have? **(Check type and indicate animal)**

---

Dairy-       Livestock       Other (*list*):  
 Cattle   Goat   Sheep      Beef   Goat   Sheep

---

Do you consider yourself a  part-time or  full-time producer? **(Check one)**

On average, how often do you move animals or give them access to fresh pasture throughout the grazing season?

- 
- Less than once a month  
 Less than once a week  
 About once a week  
 Every 4 to 6 days  
 Every 2 to 3 days  
 Once a day  
 Twice a day or more
- 

Where have you received information about Mob Grazing? **(Check more than one if applicable)**

- 
- Other farmer(s)  
 Government agency person (Extension, NRCS, etc.)  
 Industry contacts or colleagues  
 Conference presentation  
 Industry publication (*choose one: Online or Print*)  
 Non-profit publication (*choose one: Online or Print*)  
 Extension article (*choose one: Online or Print*)  
 Scientific article (*choose one: Online or Print*)
- 

How has Mob Grazing been portrayed in the information you've seen?

- 
- Extremely positive  
 Very positive  
 Somewhat positive  
 Neutral  
 Somewhat negative  
 Very negative  
 Extremely negative
-

What is your personal opinion about Mob Grazing?

- 
- Extremely positive
  - Very positive
  - Somewhat positive
  - Neutral
  - Somewhat negative
  - Very negative
  - Extremely negative
- 

How would you define Mob Grazing? **(Check up to five after reading all choices)**

- 
- A higher stocking density
  - A higher stocking rate
  - A shorter grazing period
  - A longer rest period
  - Grazing mature forage
  - Grazing to a shorter residual
  - Leaving more forage uneaten
  - Allowing forage to be trampled
  - More constant moves
  - The 'herd effect'
  - None of these
  - Other **(List):**
- 

What do you believe the **positive benefits** of Mob Grazing are? **(Check up to five after reading all choices)**

- 
- |   |   |
|---|---|
| <input type="checkbox"/> Decreased selectivity (animals eat more types of forage) | <input type="checkbox"/> Season extension   |
| <input type="checkbox"/> Weed control   | <input type="checkbox"/> Animal health  |
| <input type="checkbox"/> Increased organic matter                                 | <input type="checkbox"/> Resilience (can withstand extremes such as drought or flood) |
| <input type="checkbox"/> Increased soil moisture                                  | <input type="checkbox"/> Increased production (meat or dairy etc.)                    |
| <input type="checkbox"/> Increased forage amount                                  | <input type="checkbox"/> None of these  |
| <input type="checkbox"/> Increased forage diversity                               | <input type="checkbox"/> Other <b>(List):</b>   |
| <input type="checkbox"/> Increased wildlife diversity                             |   |
| <input type="checkbox"/> Even distribution of nutrients                           |   |
| <input type="checkbox"/> Ability to increase number of animals                    |   |
| <input type="checkbox"/> Increased profitability                                  |   |
- 

What do you believe the **disadvantages** of Mob Grazing are? **(Check up to five after reading all choices)**

- 
- |  |   |
|--|---|
| <input type="checkbox"/> Increased labor | <input type="checkbox"/> Increased time |
|--|---|

- Decreased animal health
- Soil compaction
- Decreased profit
- Decreased soil quality
- Decreased production
- Only applicable in some environments
- Only works with some animals
- Increased erosion
- Decreased forage quality
- None of these
- Other (***List***):

Which source of information about Mob Grazing would have the greatest impact on your adoption of the practice? ***(Check more than one if applicable)***

- 
- Other farmer(s)  
 Government agency person (Extension, NRCS, etc.)  
 Industry contacts or colleagues  
 Conference presentation  
 Industry publication (*choose one: Online or Print*)  
 Non-profit publication (*choose one: Online or Print*)  
 Extension article (*choose one: Online or Print*)  
 Scientific article (*choose one: Online or Print*)
- 

Do you use Mob Grazing?

- 
- Yes  
 No
- 

**If you've used Mob Grazing on your farm, please continue. If you've never used Mob Grazing on your farm, please stop here.**

For what percentage of the grazing season do you utilize Mob Grazing?

- 
- 0-25%  
 26-50%  
 51-75%  
 76-100%  
 100%
- 

What is your average herd size?

- 
- 0-25 animals  
 26-50 animals  
 51-100 animals  
 101-200 animals  
 201-400 animals  
 Over 400 animals
- 

How often, on average, do you move the animals?

- 
- Less than once a day (more than a day between moves)
-

- 
- Every day
  - 2-3 times a day
  - 4-5 times a day
  - 6-7 times a day
  - More than 8 times a day
- 

How long, on average, do you rest a paddock before it is grazed again?

- 
- 20-30 days
  - 31-40 days
  - 41-50 days
  - 51-60 days
  - 61-70 days
  - 71-80 days
  - More than 80 days
- 

What is the average height in inches of residue after grazing event:

- 
- Fewer than 4
  - 4-5
  - 6-7
  - 8-9
  - Greater than 10
- 

What is the average stocking density when Mob Grazing (in lbs/acre at any given time):

- 
- 0-50,000 lbs
  - 50,001 - 100,000 lbs
  - 100,001-250,000 lbs
  - 250,001-500,000 lbs
  - 500,001-750,000 lbs.
  - 750,001-1,000,000 lbs
  - Over 1,000,000 lbs.
- 

How concerned are you about forage quality?

- 
- Extremely
  - Very
  - Somewhat
  - Unlikely
  - Not
-

