5-2013

Differences in the Health of Domesticated Sheep (Ovis aries) Pastured in Wild and Agricultural Landscapes

Corine Giroux
University at Albany, State University of New York

"Differences in the health of domesticated sheep (*Ovis aries*) pastured in wild and agricultural landscapes"

Corine Giroux

An honors thesis presented to the
Department of Biological Sciences
University at Albany
State University at New York
In partial fulfillment of the
Honors Program Requirements

Corine Giroux
2013

The Honors College
University at Albany

BIOLOGICAL SCIENCES
Certification of the Completion of a Senior Honors Thesis

- Successful completion of a senior honors thesis is required for graduation from The Honors College.
- The determination of whether a student's work satisfies the criteria for a senior honors thesis is left to each department.
- Each honors student must return this completed certification, along with an electronic copy of his or her senior honors thesis, to the honors college office.
- This certification must be signed by the student's thesis advisor and by either the Director of the department's honors program or the Chair of the department.

This Honors Thesis has been read and approved by the signatures below and, is hereby recommended for acceptance.

Student Name: Corine Giroux Student ID 000988949

Thesis Title: Differences in the health of domesticated sheep (Ovis aries) pastured in wild and agricultural landscapes

Department in which Thesis was completed: **BIOLOGICAL SCIENCES**

Honors Thesis **Presentation Date** 4/26/2013

	Print name	Signature	Date
Honors Thesis Research Advisor:	Gary S. Kleppel		5/3/2013
Honors Thesis Committee Member:	Jeffrey L. Travis		5-3-2013
Honors Comm. 2nd Member: (optional)			

CHOOSE ONE: ☒ **Department Chair** OR ☐ Director of Department Honors Committee

	Print name	Signature	Date
Biology Honors Committee Director & Department Chair	RICHARD S. ZITOMER		

Original Files in Biology Department
Email Copy to Dr. Jeffrey Haugaard LC-31
DARS Exception Honors Thesis to Registrar

Abstract

The purpose of this study was to compare the health of sheep grazed in a quasi-wild landscape (Norman's Kill Farm, an abandoned dairy) as part of a targeted grazing research project, to that of sheep in a conventional agricultural pasture setting (Longfield Farm). This study tested the null hypothesis that there is no difference between the health and nutrition of sheep in a domestic setting and those in a wild setting. Sheep on the quasi-wild landscape were healthier than those on the agricultural setting, having healthier body condition scores. The mean body condition scores of the sheep at Longfield was 3.48 with a standard deviation of 0.69, and at Norman's Kill the mean body condition score was 3.30 with a standard deviation of 0.27. The Norman's Kill flock had a more ideal body condition score (the standard is 3.0), as well as less variable body condition scores. The sheep also had access to and consumed a more diverse diet than those in the pastoral setting, as shown by the microhistological determination of the diet. It would appear that quasi-wild landscapes offer a more nutritionally diverse environment than conventional pastures, which, in turn, can produce healthier livestock.

Acknowledgements

I would like to thank Dr. Gary Kleppel, for all his help and support on my research projects over the past two years. I would also like the thank Caroline Girard (and Jinx) for helping me wrestle sheep every week, as well as all her support in the lab. I would like to thank Erin Labarge for all her help and support in the field and in the lab. I would also like to thank Dr. Jeff Travis for agreeing to edit this paper and helping me out in a bind. I would like to thank my lovely roommates, Kaylie, Lauren, and Laura, Alex Talamo and Sam Chu for all their moral and academic support this past week and year. Last but not least I would like to thank my parents, for all of their support for the past 22 years.

Table of Contents

Introduction

Grazing is a fundamental biological process and, while enormous herds of grazing ungulates once moved over vast grasslands, today these have been largely replaced by domesticated grazers in human dominated landscapes. There is considerable interest in grazing in these human dominated landscapes. Food and wool are produced on these landscapes to feed and clothe a burgeoning human population; whether these landscapes are be maintained or degraded will depend on the livestock that we graze on them. The research of Dr. Kleppel's laboratory focuses on developing sustainable grazing and understanding herbivory in human dominated ecosystems.

Agriculture is key to food and fiber production. There are important consensuses that many of today's agricultural practices are not sustainable (McLaughlin and Mineau, 2005). Once such, concerning loss of biodiversity is that over one half of Canadian wetlands have been drained, 85% of these for agriculture. This drainage has resulted in significant losses of biodiversity and habitats for wetland organisms (McLaughlin and Mineau, 2005). Drainage has also caused an increase in pollutant levels in the remaining drainage water. Other current practices that are not sustainable include tillage, and the use of synthetic fertilizers and pesticides (McLaughlin and Mineau, 2005). Tillage destroys ground dwelling bird and small mammal habitats, and it increases the soil's susceptibility to erosion by both wind and water, which negatively affects organic carbon and nitrogen levels in the top layers of soil (McLaughlin and Mineau, 2005). Perhaps the most dramatic example of this occurred during the Dust Bowl, which took place the United States in

the 1930s, when over 40 million acres of farmland were ruined due to poor farming practices and subsequent erosion (McLaughlin and Mineau, 2005). The use of pesticides also results in habitat loss, and sometimes the wrong species is eradicated (McLaughlin and Mineau, 2005). The use of synthetic fertilizers suppresses beneficial soil enzymes (McLaughlin and Mineau, 2005).

Livestock grazing may be used in specific ways that mimic wild ungulate movement and aggregation patterns, and landscapes on which ungulates are grazed in this way may benefit in terms of soil quality, biodiversity and overall ecosystem functionality (Savory 1983; Kleppel et al. 2011; Giroux and Kleppel 2012). Targeted grazing, (the use of livestock for vegetation management) for instance, has proven to be effective in the control of invasive plants (Kleppel et al, 2011). In an experiment conducted in 2009 in upstate New York, Boer goats successfully eradicated the invasive plant Multiflora Rose, which had taken over a pasture and made it so that farmers could no longer graze their cattle there (Kleppel et al, 2011). The overall species richness of the pastures also increased, suggesting that the health of the ecosystem increased as well. A similar experiment was performed using Romney sheep to target the invasive plant purple loosestrife, which demonstrated similar results; the sheep suppressed the population of invasive plant and species richness increased (Kleppel et al, 2011).

Frank and Groffman (1998) showed that large herbivorous ungulates were also improved the soil quality in a wild setting, i.e., in Yellowstone National Park. This study showed that herbivory influenced soil geochemistry, as it was previously thought that climate and topographic elements were the only factors that influence

soil carbon and nitrogen levels (Frank and Groffman, 1998). The study focused on hills, slopes, and bottomlands, and found that ungulates affect soil nutrient dynamics (Frank and Groffman, 1998). The average net N mineralization in grazed areas was double that in ungrazed areas. Grazing also increased the organic matter quantity of the soil (Frank and Groffman, 1998).

It is apparent from these studies that grazing livestock may have multiple positive influences on the landscape, and is a more sustainable and beneficial practice than other land management techniques used in agriculture. Our efforts to use livestock to manage the vegetation in a wild and quasi-wild landscapes leads us to investigate the effects of these kinds of plant communities on the overall health of the animals. Livestock are bred to graze in pastures containing near-monocultures of grasses. What does the potentially diverse diet obtained in human-dominated, but largely unmanaged landscapes do to the health of the animal?

This experiment was designed to address that question. I compared the health of sheep that were being used to manage a quasi-wild (abandoned pasture) landscape to the health of sheep that are grazed in a conventional pastoral setting. In this study the quasi-wild landscape tends to have diverse food sources (graminoids, forbs, shrubs both cultivated and invasive as well as well as wild native plants). The managed pasture tends to be more monophyletic in vegetation.

Methods and Materials

Description of Landscapes

The study was conducted on sheep maintained in two landscapes, Norman's kill Farm, in Albany, New York and Longfield Farm, in Knox, New York, about 30 km west of Albany. Norman's Kill farm is an abandoned dairy farm. The land that the sheep were pastured on has been unmanaged by people for about the past half-century, and now represents a wild grassland, as plants have been allowed to grow unmanaged and uninhibited. Longfield farm is a conventional agricultural setting, and has been mowed and managed by people for the past nine years. The soils at both locations are clay and clayey-loam. The terrain at Norman's Kill farm is hilly and rugged, while at Longfield the pastures slope gently upward from north to south.

Veterinary Measurements

I was the veterinary officer for our experimental flock of sheep at Normanskill Farm this past summer, routinely giving the sheep physical exams. Each day, I monitored the general "wellness" of the flock, looking for symptoms such as lameness and lethargy, and checking for abrasions, signs of soreness and hoof morbidity. Each week I examined each animal for overall wellness (body condition) and the presence of the parasite *Haemunchus contortus* (FAMACHA technique) an especially pathological annelid (Lewandowski, 2010).

The principal method used to assess the overall wellness or health of the sheep was body condition (BC) scoring. Body condition scoring evaluates the amount of muscle and fat around the spine (Phythian et al, 2012). It is a widely accepted method for ascertaining the nutritional status of an animal (Phythian et al, 2012). Body condition score is measured on a 5-point scale. Each point on the scale represents about 20% of the sheep's body condition. An assessor physically palpates the loin muscles of the sheep and estimates the body condition as a function of the extent to which the vertebrae are covered with fat. A score of 1.0 indicates emaciation; an animal with a score of 5.0 is obese. A body condition score of 3.0 is the considered ideal (Phythian et al, 2012). A study of between-assessor precision of the scoring method revealed no between-assessor bias (Phythian et al, 2011).

Body condition scores were assessed every week from mid-May through mid-August for two years on two flocks of sheep at Norman's Kill farm. In 2011, another veterinary officer managed a flock of 14 sheep (Norman's Kill flock 1) In 2012, I managed 17 sheep (Norman's Kill flock 2). I used the data from both years in this study. For the Longfield flock, I used records for body condition score that dated from 2008 to 2012 for the same 16 sheep. The deviation of body condition score from the ideal value of 3.0, which I will refer to as the body condition anomaly, was calculated by subtracting 3.0 from the mean body condition score of each sheep. The absolute value of the body condition anomalies for each flock was calculated as well, so that the positive and negative values would not cancel each other out when the mean was computed.

Species Richness of Vascular Plant Communities

The number of species in each of 6-12 randomly deployed 0.25 m^2 quadrats were enumerated in August 2012 by C. Girard at Norman's Kill Farm and in September 2012, by the University at Albany Bio 327 Experimental Ecology class (G. Kleppel, instructor). Species richness is measured by counting the number of different plant species in each quadrat. These data were made available to me for use in this project.

Forage Analysis

Forage samples were collected in November 2012 at each farm, packaged in Ziploc plastic bags and sent to Dairy One Analytical Laboratory in Ithaca, New York, for analysis by near infrared reflective spectroscopy. The following variables were of interest in this study: crude protein, crude lipid, total dry matter and the calcium to phosphorus (Ca:P) ratio. Protein is vital to many life processes in the sheep. If a sheep is protein deficient, the sheep will not only eat less but will utilize the energy she does ingest less efficiently (Anonymous, 1985). Protein is essential for growth, as well as for milk and wool production. If a sheep becomes protein deficient, she may develop anemia, lose weight, and have less resistance to disease (Anonymous, 1985). Alternatively, a sheep can ingest excess protein without it being toxic (Anonymous, 1985).

Calcium and phosphorus are essential to the skeletal system of sheep (Anonymous, 1985). If a sheep is deficient in calcium and phosphorus it could lead to rickets in young animals and osteomalacia (the softening of bones) in older

animals. Most forage across the United States provides adequate calcium levels, and excess calcium is not dangerous as long as the sheep is also receiving phosphorus (Anonymous 1985). Sheep can endure a calcium (Ca) to phosphorus (P) ratio as high as 5 or 6:1 but the optimal Ca:P ratio is 2:1 (Kott, 2006). However, long-term ingestion of more than 2 or 3 times the required phosphorus can lead to bone resorption (Anonymous, 1985).

Sheep Diets

The diets of sheep on both landscapes were estimated by microhistological analysis of their fecal material (Hayden 1966). Random samples of sheep feces were collected from each pasture in August of 2012. Samples were blended together, dyed and mounted permanently on microscope slides. Reference slides were prepared from plant material gathered in each pasture. The slides were examined at 100x magnification. Eight slides were prepared for each pasture. Ten fields were examined on each slide. The percent composition of functional groups -- grasses, forbs, and dominant shrubs -- was determined in each field on each slide, and these were averaged for each pasture.

Results

Figures 1(a and b) show the body condition scores and their deviation from the ideal value of 3.0 for the flocks at Longfield Farm (conventional pasture) and Norman's Kill Farm (quasi-wild landscape) in 2011 and 2012, respectively. Each bar on the graphs represents an average BC for one sheep. It is apparent that BC values deviated further from a score of 3.0 and were more variable among sheep at Longfield farm than at Norman's Kill Farm. The average body condition score ($\pm$ standard deviation) for sheep in the conventional pasture, Longfield farm, was 3.48 $\pm$ 0.69. The average body condition for sheep in the quasi-wild setting, Norman's Kill farm, was 3.30$\pm$ 0.27. The magnitude of the differences between body scores on different landscapes is confirmed when we consider the average absolute deviation in body condition among farms (Fig. 2). The difference between mean absolute body condition score deviations was significant (Student's t-test=2.71; n=42;$p < 0.01$).

Vascular plant species richness in the pastoral system (Longfield Farm) was 2.3. Species richness in the quasi-wild landscapes at Norman's Kill Farm was 9 (Number of plant species per quadrat) Mean species richness at the Norman's Kill Farm was significantly higher (Student's t; $p < 0.001$) than that at the Longfield farm (Fig. 3a and b).

Microhistological analysis of the fecal pellets from sheep grazed at Longfield Farm, revealed that the diet consisted of 87.7% grasses and 12.3% forbs (Fig. 4a). In the quasi-wild landscapes of Norman's Kill Farm, the diet of the sheep was more diverse, consisting of 75.8% grass, 12.3% forbs, and 11.79% shrubby plants (e.g.,

Multiflora Rose)(Fig. 4b) A chi-square goodness of fit test indicates that the frequency distributions of components of the two diets were different (chi-square= 11.89, n = 80, and $p < 0.01$).

Both the Norman's Kill and Longfield Farms provide adequate crude protein to the sheep that graze there, with values of 22.2% and 18.9% of dry matter, respectively (Table 1). The standard value for proper nutrition is 9.4%, and there is no consequence in sheep for consuming excess amounts of protein (Anonymous 1985). The forage in the wild setting, at Norman's Kill Farm, had a substantially higher calcium:phosphorus (Ca:P) ratio than at Longfield Farm. The Ca:P ratio at Longfield farm was 0.85, while the ratio at Normans Kill Farm was 2.23, closer to optimal value of 2.0 (Kotts, 2006).

	Dry Matter	**Crude Protein**	**Crude Fat**	**Ca/P**
Longfield (Pasture)	28.4	18.9	3.1	.85
Norman's Kill (Wild)	21.6	22.2	4.9	2.23

Table I: Dry matter, crude protein, crude fat, and calcium to phosphorus values for Longfield and Norman's Kill landscapes from the forage analysis.

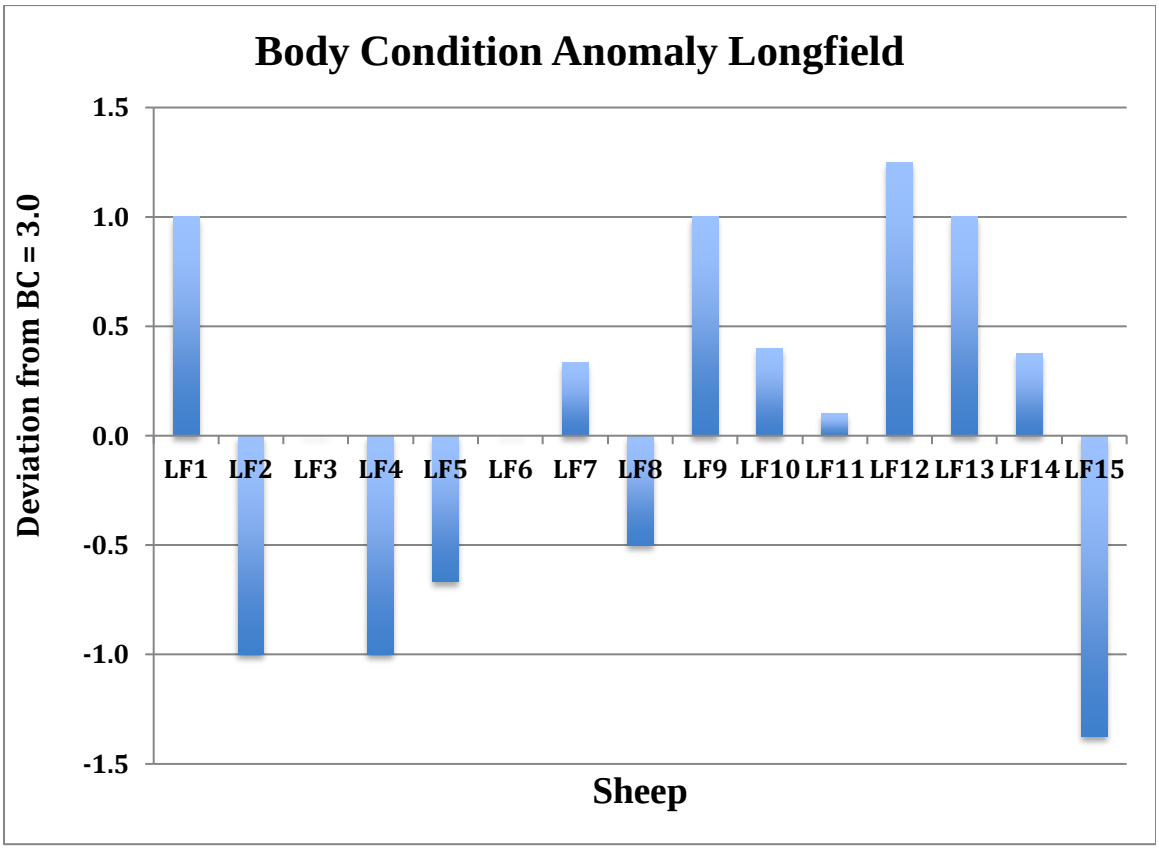


Figure 1(a): Body condition anomaly for the sheep in the domestic landscape (Longfield farm). Deviation from 3 is represented up the left axis, body condition up the right axis, and each individual sheep on the horizantal axis. Over summer seasons 2009-2012.

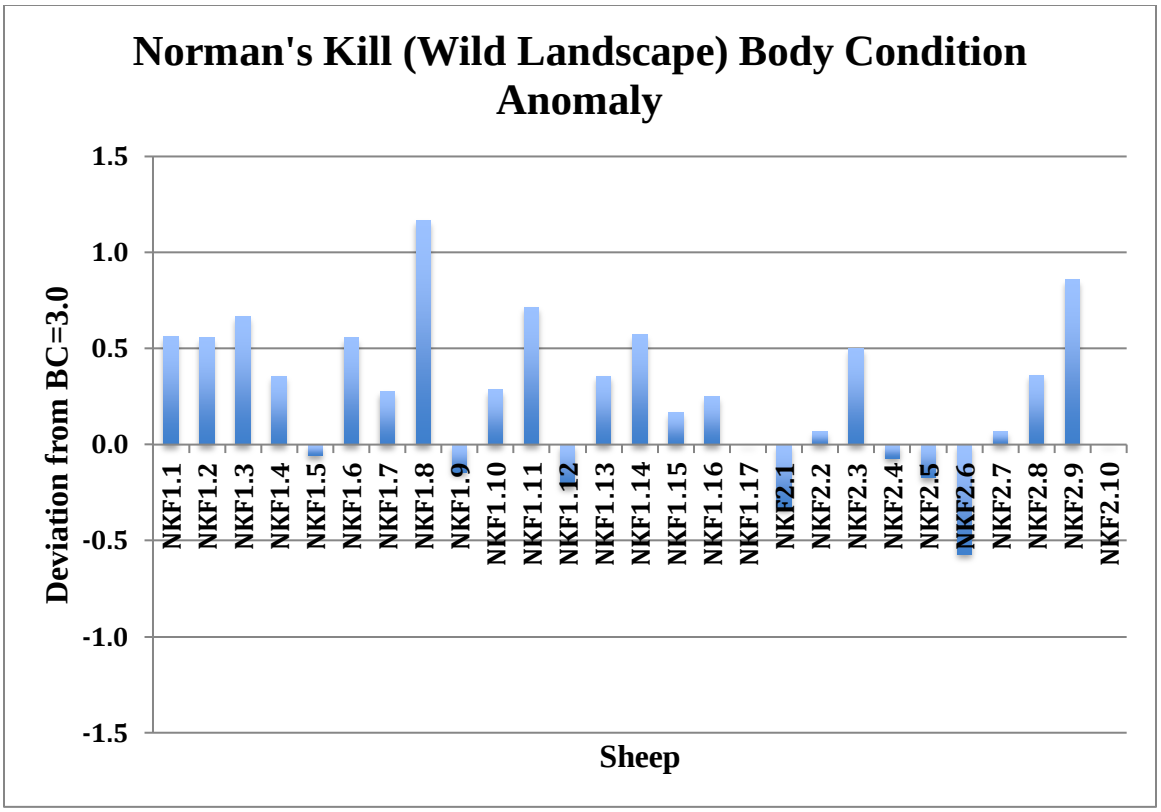


Figure 1(b): Body condition anomaly for the sheep in the wild setting (Norman's kill farm). Deviation from 3 is represented up the left axis, body condition up the right axis, and each individual sheep on the horizantal axis. Over summer seasons 2011-2012.

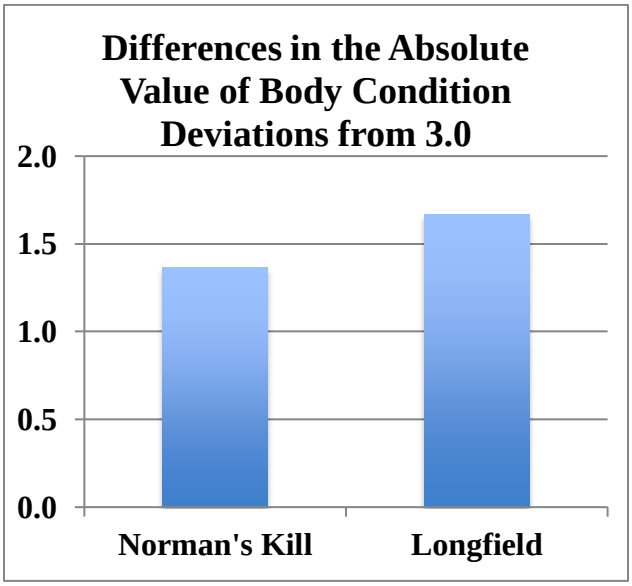


Figure 2: Means of the absolute value of the body condition deviation from an ideal score of 3.0 for each of the flocks.

Mean Plant Species Richness at Norman's Kill and Longfield

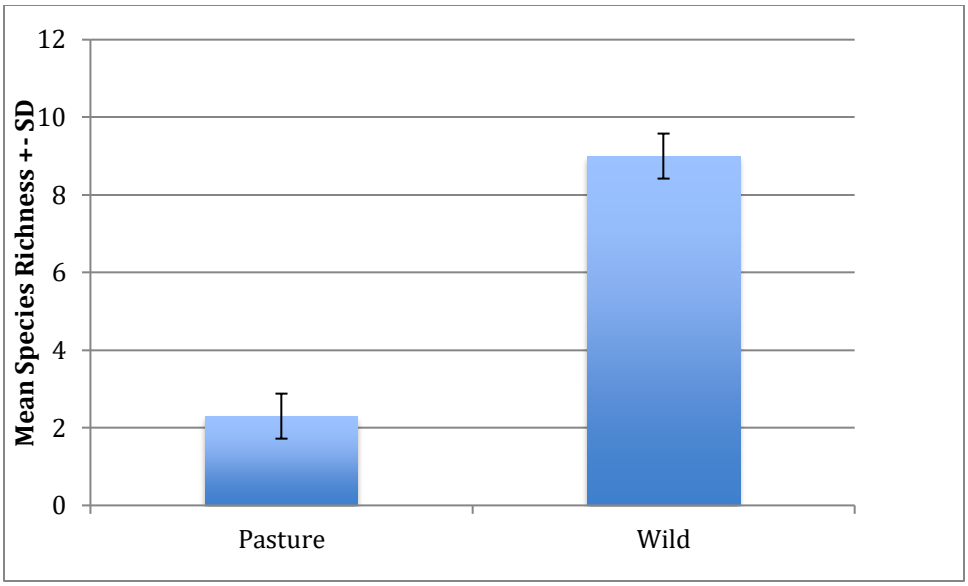
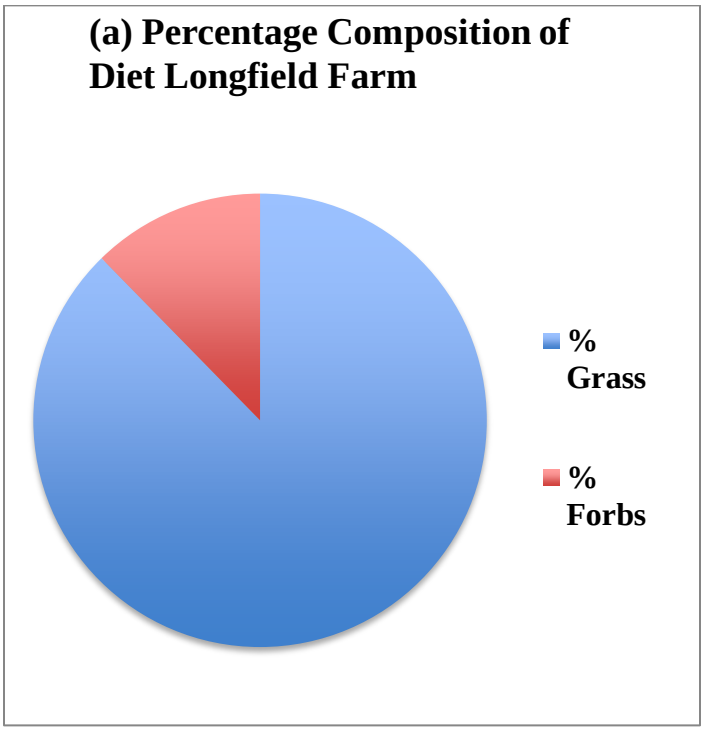


Figure 3: Mean plant species richness at Longfield Farm (pasture; data from Bio 327 Experimental Ecology class) and Norman's Kill Farm (wild landscape; data from C. Girard).



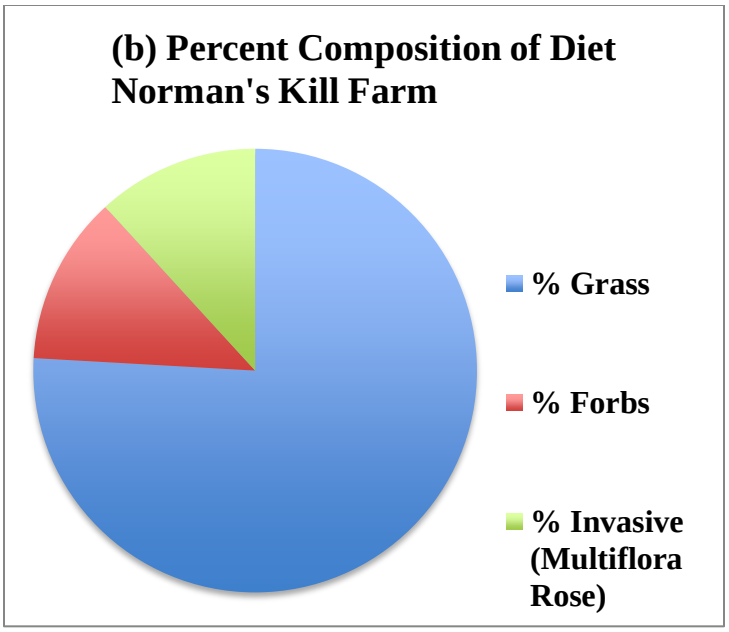


Figure 4 (a): Microhistological analysis of the diet of the sheep on the Longfield pasture. (b): Microhistological analysis of the diet of the sheep on the Norman's Kill landscape.

Discussion

Animals in the quasi-wild setting (Norman's Kill Farm) appeared to be healthier than those in the conventional pasture (Longfield Farm). Although many factors may influence the health of livestock, differences in plant community structure and nutritional composition and the resultant composition of the animals' diets seem to have contributed significantly to differences in overall health of the sheep in these different landscapes.

The average body condition score for sheep at Longfield farm, was 3.48, while the average body condition for sheep on Norman's Kill farm, was 3.28, indicating that the sheep in the wild setting were closer to the ideal body condition

score of 3.0, and therefore, healthier overall, than the sheep in the domestic setting. The body condition scores for the sheep in the Norman's Kill landscape were also less variable than those in the Longfield farm landscape, as the standard deviation for the Norman's Kill farm was 0.38, compared to 0.70 for the Longfield farm. This suggests that the body condition of the Norman's Kill flock was more stable than that of the Longfield flock . Weight-stability would also seem to be an indication of overall physical well-being.

The average deviation in body condition from the ideal of 3.0 was 0.261for sheep at the Norman's Kill Farm, while the average for Longfield farm was 0.314, which suggests that sheep at Longfield varied further from the ideal body condition score of 3.0. There were also more sheep on Longfield farm that had body condition deviations above 1.0, indicating that their body fat was more than 20% away from the ideal. This may be because the sheep grazing in the rugged terrain at Norman' s Kill Farm are more active, than those on the less hilly Longfield Farm. The greater amount of exercise that the Norman's Kill sheep receive may improve their fitness.

As such, the sheep at Norman's Kill expend more energy in their daily ambit, which could may explain their lower body fat (i.e., condition factor) levels. Finally, the quality of the forage in the pasture may depend on the quality of the soil, so differences between the soils at the Longfield and the Norman's Kill Farms may contribute to differences in the overall health of the sheep.

The microhistological analysis suggested that the sheep in the quasi-wild setting, at Norman's Kill Farm, consumed a more diverse diet than the sheep at Longfield Farm (figures 4 a, b). Possibly, the sheep at the Norman's Kill farm have

healthier and less variable body condition scores, because they consumed a more diverse diet than sheep at Longfield Farm. Diversity in diets has been found to provide more nutrition across the animal kingdom, from humans (Rathnayake et al, 2012), to organisms as small as copepods (Kleppel and Burkart, 1995). In a study done on the elderly population in Sri Lanka, it was found that an increase in the number of different foods consumed as well as an increase in the number of food groups included in the diet resulted in an increase in nutrient intake (Rathnayake et al, 2012). Kleppel and Burkart found that when copepods were fed a mixture of food organisms their daily egg production increased to more than it was when they were fed each kind of food organism individually.

Conclusions

It would appear from this study that sheep in a wild landscape were healthier than those on conventional pasture because they had access a greater diversity of forage. This is significant because the use of livestock to manage landscapes appears to be a sustainable practice in agriculture and conventional agriculture tends to promote grazing in grass-monocultures. The concept that dietary diversity is integral in an organism's health seems potentially unifying in biology.

References

Anonymous. (1985). *Nutrient requirements of sheep* . (6th ed.).: National Academy of Sciences, Washington, DC

Frank, D., & Groffman, P. (1998). Ungulate vs. landscape control of soil c and n processes in grasslands of Yellowstone National Park. *Ecology*, *79*, 2229-2241.

Hayden, P. Food habits of black tailed jack rabbits in Southern Nevada. J. Mammal. 47: 42-46.

Kleppel, G.S., Burkart, C.A. (1995). Egg production and the nutritional environment of *Acartia tonsa*: the role of food quality in copepod nutrition. *ICES J. Mar.* Sci. 52 (3-4): 297-304.

Kleppel, G., Girard, C., Labarge, E., & Cagiano, S. (2011). Invasive plant control by livestock: From targeted eradication to ecosystem restoration. *Ecological Restoration*, *29*(3), 209-211.

Kott, R. (2006). Nutrition part 1 - section 5 of 7. In *Montana Farm Flock Sheep Production Handbook* Retrieved from http://animalrangeextension.montana.edu/articles/sheep/Flock Handbook/Nutrition-1.htm

Lewandowski, R. (2010, June 16). *Use FAMACHA correctly*. Retrieved from http://sheep.osu.edu/2010/06/16/373/

McLaughlin, A., & Mineau, P. (1995). The impact of agricultural practices on biodiversity. *Agriculture, Ecosystems, and Environments*, *55*, 201-212.

Phythian, C., Hughes, D., Michalopoulou, E., Cripps, P., & Duncan, J. (2012). Reliability

of body condition scoring of sheep for cross-farm assessments. *Small Ruminant Research*, *104*(1-3), 156-162. Retrieved from http://dx.doi.org/10.1016/j.smallrumres.2011.10.001

Rathnayake, KM, Madushani, PAE, Silva, KDRR. (2012). Use of dietary diversity score as a proxy indicator of nutrient adequacy of rural elderly people in Sri Lanka. *Research Notes.* 1-6. Retrieved from http://ehis.ebscohost.com/ehost/pdfviewer/pdfviewer?vid=3&sid=17fd04fb-d6e0-42d1-96d3-c1371c74a163%40sessionmgr115&hid=101

US Department of Agriculture, Agricultural Research Service. (1989). *Near infrared reflectance spectroscopy (nirs): Analysis of forage quality* (Report no. 643). Retrieved from website: http://naldc.nal.usda.gov/download/CAT89919964/PDF