TEXAS CAMELID HEALTH AND MANAGEMENT SURVEY

A Thesis

by

BRENDA LOUISE JACKLITSCH

Submitted to the Office of Graduate Studies of
Texas A&M University
in partial fulfillment of the requirements for the degree of

MASTER OF SCIENCE

August 2007

Major Subject: Epidemiology

TEXAS CAMELID HEALTH AND MANAGEMENT SURVEY

A Thesis

by

BRENDA LOUISE JACKLITSCH

Submitted to the Office of Graduate Studies of
Texas A&M University
in partial fulfillment of the requirements for the degree of

MASTER OF SCIENCE

Approved by:

Chair of Committee, Margaret Slater
Committee Members, Bo Norby
James Jensen
Head of Department, Evelyn Tiffany-Castiglioni

August 2007

Major Subject: Epidemiology

ABSTRACT

Texas Camelid Health and Management Survey. (August 2007)

Brenda Louise Jacklitsch, B.S., Texas A&M University

Chair of Advisory Committee: Dr. Margaret Slater

A web-based and mail-out survey instrument was created to gather information on camelids in Texas. Information on management, nutrition, diseases, and reproductive problems was collected. The objectives of this research study were: (1) to establish prevalence of various diseases in alpaca and llama populations in Texas; (2) to evaluate association between potential management/nutrition risk factors and specific diseases/reproductive problems; (3) to determine how many camelids are kept in Texas and what their use is; (4) to determine possible disease clustering through spatial analysis. The survey results included 2,079 camelids on 125 farms within Texas. The top five camelid diseases in this sample were intestinal parasites, incisor overgrowth, mites, heat stress, and colic. Univariate analysis and multivariable modeling found associations between potential risk factors and these diseases.

To my family and friends.

My mother, for encouraging my love of animals. Whether it was allowing me to help nurse a squirrel back to health or simply providing me with Ranger Rick magazines so I could read about arctic foxes and baby raccoons.

My father, for always encouraging me to do better and go farther. We butted heads a lot over the years, but whenever I found myself being defeated by a course, he was there with all his stubbornness, pushing me to keep trying.

My brother, for being a source of answers to the questions I had not thought to ask. He was always talking about what he read when we were kids. This gave me an insight to various branches of science I probably would not have learned about on my own. In addition, I believe this caused me to try harder in school and gave me a thirst to learn more, just so I could have the chance to tell my brother something he did not already know.

My friends, for being there for me these past couple years. Melanie and Alice were with me when I started and saw me through until the end. They gave me strength and continued to laugh at the same photos in my numerous llama presentations throughout the semesters.

My cat, Gaby, for arriving in my life at just the right moment. I knew from the moment I heard her loud, heartbreaking cry in that tree, she was meant to be mine. She has provided a daily source of laughter even on my toughest days.

ACKNOWLEDGEMENTS

I would like to thank Dr. Margaret Slater, my committee chair, for all the time she has spent guiding me during this project and for encouraging me to make the thesis better with every revision. I would also like to thank Dr. Bo Norby for his time and effort with helping me with the survey and writing. In addition, I would like to thank Dr. James Jensen for giving me the basis of this Texas camelid project and the many sources of information related to camelids.

Special thanks to South Central Llama Association and TxOLAN for allowing me to access their membership records in order to find my sampling frame.

TABLE OF CONTENTS

Page

LIST OF FIGURES

Page

LIST OF TABLES

Page

I. INTRODUCTION: THE IMPORTANCE OF THE RESEARCH

Little information is known or available in writing concerning the health and management of the llama and alpaca populations in Texas. Disease prevalence for particular diseases had not been previously determined in this statewide camelid population. Llama and alpaca owners are often considered not as experienced in livestock care as livestock producers. However, these camelids are at least as susceptible to a wide array of diseases and disorders as cattle, and they require special care in order to be productive in the state of Texas. This study was designed to look at how management practices and nutrition have an affect on disease status and reproduction problems in alpacas and llamas. Through this research, more information was attained about these South American camelids in Texas.

The objectives of this research study were: (1) to establish prevalence of various diseases in alpaca and llama populations in Texas; (2) to evaluate the associations between potential management/nutrition risk factors and specific diseases/reproductive problems; (3) to determine how many camelids are kept in Texas and what their use is; (4) to determine possible disease clustering through spatial analysis. This initial study will give an overall picture of domesticated camelids in Texas, so that future studies can look more specifically at common problems.

This thesis follows the style of the journal, *Journal of the American Veterinary Medical Association*.

II. LITERATURE REVIEW

2.1 Camelid Background

Llamas and alpacas have gained much popularity in recent years. This may be occurring as more people from urban areas decide to move to rural areas for the purpose of having a more laid back lifestyle. Approximately 100,000 llamas and 8,000 alpacas were owned in the United States as of 1997.[1] The National Agricultural Statistics Service's Census of Agriculture included information about llamas in Texas in 2002. The census data included information on llamas for 185 of the 254 Texas counties.[2] The data from the census shows that there were 1,539 llama farms in Texas and a total of 9,067 llamas within the 185 counties.[2]

Llamas and alpacas belong to the South American Camelids group. The South American Camelids are adapted for cooler temperatures and are prone to heat stress.[1] While the llama and alpaca have been domesticated, the South American Camelid group also contains two non-domestic species, the vicuna and guanaco. The sizes of these four species vary with llamas being the largest followed by guanacos, alpacas, and vicunas.[3] Adult llamas may weigh between 110 to 205 kilograms (250-450lbs.).[4]

Llamas and alpacas are kept for a wide variety of purposes. These animals may be kept as companion animals, fiber producers, pack animals, cart pullers, or guard animals. Adult pack llamas can carry between 30 and 40 kilograms (70-90lbs.).[5]

Llamas are often used as guard animals for sheep herds. These animals are very territorial and are known to be aggressive when approached by wild dogs or coyotes. In the early 1980s, sheep ranchers in North America began using guard llamas for their herds.[6] Successful guard llamas require no training or previous association with sheep. Females and gelded males are most often used as guard animals. Intact males are not recommended because they may try to breed ewes and cause injuries.[6] It has also been found that a single llama per flock is more effective than two or more llamas, because a single llama will more likely bond with the flock if no other llamas are around.[6] Llamas use a variety of methods to protect their herd. They will run after predators, stomping and hitting with their chest and legs. They are also known to herd the sheep to a safe area away from the predator. Llamas will also create a high-pitched alarm call when they spot a predator. Other useful guard behaviors include seeking out help when needed and lying next to newborn lambs to protect them from bad weather.[6]

2.2 Management and Husbandry

2.2.1 Housing

When housing llamas, the climate of the area is an important factor. Llamas will need some form of shelter whether it is trees, sheds, or barns.[7] Llamas enjoy their sense of freedom and prefer being able to come and go as they please.[7] In areas with high temperatures and high humidity, shade is necessary to prevent heat stress. Other options for deterring heat stress include: sprinklers, misters, streams, ponds, and plastic wading pools.[7]

In areas that experience a lot of rain, llamas will need somewhere they can go to let their feet dry out.[7] This will help in avoiding foot rot in the llamas.

Although llamas are native to a cooler climate, extreme freezing temperatures for long periods of time can cause problems. The temperature in their native Andes range from -6.7 to 12.8°C (20-55°F) and the night temperature rarely falls below -12°C (10°F).[7] In areas where temperatures are lower, three-sided sheds or enclosed shelters are recommended.[7] Another recommendation is to always have at least one stall where a mother and newborn or an ill llama can be confined.

Generally llamas will respect a traditional four foot fence used with other large livestock. However, they can also easily jump 1.4 meters (4.5 ft.) if they want to and can just as easily crawl under or through fences.[7] It is recommended that 1.7 meter (5.5ft.) high fences are used when separating stud males.[7]

2.2.2 Management

Llamas and alpacas require routine upkeep in order to prolong a healthy life. Twice a year, toenails should be checked.[4] Actual trimming may only be needed once per year if ever.[8] It is important for owners to weigh and body score their animals every one month to two months.[4] Any weight loss or decrease in body score could indicate a health related problem. At 30 to 36 months of age, intact males will develop six fighting teeth. These teeth should be cut off at the gum line to prevent injury to other llamas.[4] Fighting teeth will continue to grow until the males have reached 4 to 5 years of age, so the teeth will need to be checked every 6 months and continue to be removed.[8] Occasionally older animals will need their incisors trimmed or cheek teeth filed.

Vaccinations are important for preventive care in llamas and alpacas. Llamas are usually vaccinated with *Clostridium perfringens* type C&D and tetanus toxoid.[4] In some areas rabies, leptospirosis, or blackleg vaccinations are recommended.[4]

Llamas and alpacas instinctively deposit their manure in communal dung piles.[8] The animals will tend not to eat the grass surrounding the piles of manure. This behavior lowers their contact with parasite larvae and reduces the incidence of intestinal parasite infestation in the herd.[8] This is also a reason to not spread it around on the llamas' pasture, because the llamas will refuse to continue grazing.[8]

2.3 Diseases and Nutritional Disorders

2.3.1 Diseases

Llamas and alpacas are susceptible to a wide variety of diseases and disorders. Internal and external parasites, bacteria, viruses, and fungi all infect these animals.[9] Various parasites pose a threat to llamas and alpacas. Common stomach worms in llamas include: *Haemonchus, Ostertagia*, and *Trichostrongylus* species.[4] *Moniezia expansa*, a tapeworm found in cattle, also causes problems in llamas and alpacas.[10] Parasites can easily be spread between other domestic species that the llamas and alpacas may have contact with on the farm. Often camelids will share parasites, such as nematodes, with other species like cattle or sheep.[11] Even local wildlife may cause health risks to llamas and alpacas. For example, meningeal worms (*Parelpahostrongylus tenuis*) are found in white-tailed deer and their larva migrans stage can cause paralysis in llamas and alpacas.[11] Meningeal worms and liver flukes can be deadly to llamas and alpacas.[4] Coccidia and giardia have been reported to be common in crias.[4]

External parasites also pose a problem in llama and alpaca herds. Herds may need to be treated for flies, lice, ticks, nasal bots, and mites.[4] Fiber loss is often a result of a lice or mite infestation.[4] Although ticks are not common problems in llamas, there have been cases of tick paralysis and Lyme disease reported.[4]

Bovine Viral Diarrhea (BVD), caused by the bovine viral diarrhea virus (BVDv) is becoming a disease that is well known to many llama and alpaca owners. The cattle industry has been affected by BVDv for many years. When cattle are persistently infected, they can shed the virus quickly and in large amounts, easily infecting other cattle that come in contact.[12] Camelids infected with BVDv may suffer from respiratory problems, enteric diseases, chronic wasting, stillbirths, and abortions.[13] Bovine Viral Diarrhea virus and its effects in the camelid population are currently being researched. Another viral infection of current research interest is the West Nile Virus (WNV). The WNV has been found to infect humans and many animal species, including camelids.[14] There are currently studies to determine humoral responses of WNV vaccines in llamas and alpacas.[15] Llama plasma containing antibodies to WNV was used in alpacas as passive immunization and treatment of infection.[16]

Llamas and alpacas are susceptible to many types of bacterial infections, such as paratuberculosis caused by *Mycobacterium avium* spp. Paratuberculosis, also referred to as Johne's Disease is an important economic concern to llama and alpaca owners.[17] Johne's disease has a large impact on the cattle industry, with an estimated $1.5 billion per year loss for U.S. dairy industry.[18] This can also be a cause for concern considering the possible zoonotic association with Crohn's disease in humans.

2.3.2 Nutritional Disorders

Although often compared, nutritional needs differ between the camelids and ruminants. Camelids have only three compartments in their stomach compared to the four compartmental stomachs of true ruminants. The bacterial activity and the retention time of food particles in the forestomach are more important in camelids. More starch can be added to a forage-based diet without the negative effects seen in ruminants.[19] Camelids are capable of digesting poorer quality forage than cattle, and are often kept in areas where cattle would not be able to thrive.

Just as with other livestock, llamas and alpacas may suffer from vitamin deficiencies. Rickets is a condition created from the softening and weakening of bones, often resulting in bowing of the long bones of the body. Hypophosphatemic rickets was found in juvenile llamas and alpacas that had a vitamin D deficiency.[20] The study found that rickets in these groups were associated with the season. Selenium, copper, and zinc deficiencies have also been noted in various studies. Zinc deficiency causing alopecia, the thickening and crusting of skin cells, and other lesions is of particular concern.[21]

Obesity is also becoming a growing problem in llamas and alpacas in North America.[22] Possible causes of the increase of obesity include feeding too high a forage quality and overfeeding additional supplements.[21] Changes in diet or increases in activity levels are recommended.

2.4 Reproduction and Crias

Failing reproductive performance is a very significant problem for many llama and alpaca owners. The fibers from these camelids are graded for quality, and high quality fiber is a characteristic that is often bred for in these animals. Currently, there is a stronger research interest in reproduction. According to a study from Australia, 20% of the females will not conceive after mating and those that do conceive face a high embryonic loss.[23] Other issues that hinder breeding include the late age of onset of puberty in males, an average 350 day gestation period, and the fact that females are induced ovulators.[24] Females can usually breed at 18 months of age, while males may not reach maturity until 2 ½ to 3 years of age.[9] However, it should be noted that some females may be ready to breed as early as 4 months of age.[8] Females tend to give birth during daylight hours and normal births should be completed in about two hours.[4] Another difficulty when trying to breed these animals is llama semen has high viscosity, low motility, and low concentration of sperm.[4] Differences in management and nutrition may make a difference when breeding these animals.

Cria is a term used for neonatal llamas or alpacas. Healthy crias weigh between 11 to 17 kilograms (25-38lbs.) at birth.[4] Within an hour of birth, crias should be standing and nursing.[4] They will pass their first stool or meconium within their first 4 to 8 hours.[4] Crias should gain 227 to 454 grams (0.5-1lb.) per day their first week of life.[4] Owners must also be careful when handling and socializing their crias because male crias bottle-fed or over handled at a young age can develop Berserk Male Syndrome.[9] At 5 to 6 months of age, crias should be weaned from their mothers.[4]

2.5 Survey Development and Comparisons between Web and Mail-out Surveys

2.5.1Web survey development

Epidemiological surveys often contain more questions than a typical marketing research survey. Therefore designing a visually pleasing layout will be important.[25] Logic commands can be used to automatically hide follow-up questions, although this requires alternate layouts.[25] In a study on web survey usage in Taiwan, the number of questions, the speed of the internet, and whether or not the survey was user-friendly were the most significant concerns of the participants.[26]

Printouts of the entire questionnaire will need to be read, discussed, and rephrased multiple times before administration. This can be difficult when using web surveys that are more than one scrollable page and use logic questions.[25]

Web surveys should have a welcome screen so that respondents know they are at the correct site and this first screen should explain the purpose of the survey.[27] Dillman (1999) also suggests that the first question to appear on the screen should be easy to answer with no confusing drop-down boxes.[27] A study on web survey response options showed that the visibility of answers is important, therefore radial buttons may be preferred over drop boxes.[28] Another study supports the use of radial buttons compared with drop-down boxes.[29] Questions that may seem more complex will need immediate instructions on how to answer them.[25]

A study comparing web surveys announced by emails versus mail found that the email notices were more effective.[30] Personalized salutations in web survey email invitations were shown to increase the response rate by almost 8% according to one study.[31]

Restricted access to the web survey is important. Respondents will need to provide some form of identification before answering the survey.[25] In addition, if the survey gives any information back to the respondent such as registration data or previous survey results, methods of identification will need to be even stronger.[25]

2.5.2 Comparing web to paper surveys

Web surveys appear to be increasing in popularity in recent years. Web-based surveys can save time and money when utilized in countries with high internet access.[25] According to Balter (2005), the two main advantages are the 'immediate control of answers and instant electronic storage.[25]

When the response data is collected by the web survey then it can easily be transferred into a data file and data entry error will be minimalized.[26] These advantages may increase the accuracy of the data. Another advantage of web surveys is the reduced cost when compared to other survey methods. Paper, printing, and postage costs can be avoided or reduced when implementing a web based survey.[32]

One study found that a web survey, when compared to a telephone questionnaire, would have fewer non-responses due to the automatic prompting when leaving a blank, in addition, web respondents also took more time filling out answers to open-ended questions.[33] Another study found that responses to a web survey were returned more quickly than a mailed survey.[30] In addition to timely responses, one study has shown a 95% response rate from web surveys in comparison with a 79% response rate from mailed surveys.[34] This study also showed more 'substantive responses to qualitative questions' in the web survey responses. A survey questioning undergraduate students about illicit drug use also had a significantly higher web response rate than mail response rate.[35]

When organizations provide researchers with their member lists to establish a sampling frame, not all members will have their email included.[32] Invalid and inactive email addresses can also cause problems when trying to build a sampling frame.[32] While invalid emails may be returned to the sender with notification or error, an inactive email address will accept the email and it may never be accessed.

Technical difficulties also pose a problem with web surveys. Computer literacy, connection speed, and screen configurations can cause participants problems when answering the survey.[27]

III. MATERIALS AND METHODS

3.1 Study Design

A cross-sectional study design was implemented in this study. The sampling frame consisted of llama or alpaca owners from Texas who were current or past members (2001 to 2006) in two major Texas camelid associations. The two associations were the South Central Llama Association (SCLA) and the Texas, Oklahoma, Louisiana, Arkansas, and New Mexico Alpaca Association (TxOLAN). There were approximately 300 members in SCLA and 80 members of TxOLAN that were located within Texas. Current and past members were contacted by email or letter depending on the contact information available. These emails and letters described the research goals and requested participation via an online web survey. When responses to the web survey began to slow, a postcard letter reminder was sent out to non-respondents. Email reminders were sent four times as suggested by Dillman.[36] Former or present members of SCLA or TxOLAN who currently had camelids residing within the state of Texas were eligible to participate if they were 18 years of age and older.

3.2 Web Survey

An internet survey was administered via Texas A&M University's College of Veterinary Medicine Online Surveys Site which used Select Survey ASP Deluxe[1]. The survey included sections for adult male llamas/alpacas, adult female llamas/alpacas, and

---

[1] Select Survey ASP Deluxe 5.0, ClassApps, Clifton, NJ

crias with subcategories that included general information, management, nutrition, preventive care, reproduction, travel, housing, and diseases.

The first section included background questions, i.e. where the herd resided, how many years they had owned llamas or alpacas, and what purpose their llamas and alpacas served. This section also included questions about whether owners had llamas and/or alpacas, and whether they had males and/or females.

General care of adult animals (≥ 9 months) was covered in the second section. Various management practices were addressed, such as how often animals were sheared and what other animals could come in contact with the llamas or alpacas. Nutrition and preventive care questions were included in this section. Preventive care questions inquired about vaccinations, insect and parasite control, and manure removal. A few questions about reproductive management and travel practices concluded the general care of adult animals section.

The third section focused only on adult female llamas and alpacas. Questions for this section were more specific than the previous general care section. Management questions included housing and nutrition. The nutrition questions examined differences between three adult female groupings (i.e. non-pregnant/non-lactating females, pregnant females, lactating females). This section also included questions about health and diseases. These questions covered currently owned animals and those that died within the past three years. A variety of neurological, skin, skeletal, eye, mouth/jaw, ear, respiratory, and gastrointestinal diseases and disorders were addressed. For many of the diseases an additional question asking about who diagnosed the disease helped give strength and validity to the diagnosis. Questions about West Nile Virus, Bovine Viral Diarrhea, vitamin E-selenium deficiency, and heat stress were of particular interest. This section included questions about female breeding and reproduction. These questions focused on the frequency of breeding females, prevalence of abortions and stillbirths, and questions about breeding and parturition.

The fourth section was very similar to the third section, except the questions asked about the adult male llamas and alpacas. The majority of the questions were the same as those of females in the third section, so that we could obtain and evaluate differences in management and diseases between the sexes. The fourth section also included diseases and male breeding/reproduction questions.

Questions about crias were addressed in the fifth section. Crias were classified as llamas or alpacas that range in age from newborn to eight months of age. Some of the questions in the fifth section were related to how the newborns were handled, what kind of shelter was available, and what additional nutritional supplementations were provided. This section also included questions about health and diseases. Many of the questions were the same as those in the third and fourth sections. However, questions related to birth defects that might hinder survival were also included. Birth defects of interest included heart defects, atresia ani, choanal atresia, and whether the cria was born premature.

Responses to the survey were kept confidential. When the data was exported from the website to an Excel file, each participant was assigned a number code.[2] A

[2] Microsoft Excel 2002, Microsoft Corporation, Redmond, WA

paper copy of the entire internet survey was reviewed and approved by the Institutional Review Board for Human Subjects at Texas A&M University.

3.3 Statistical Methods

3.3.1 Response Rates

The number of possible respondents was calculated from the combined lists of former and current members of SCLA and TxOLAN. Each member was noted as having valid emails or mailing addresses. As responses arrived, unusable responses were noted. Mail and web responses were combined to calculate the overall response rate.

3.3.1 Descriptive Statistics

Descriptive statistics were calculated for all variables. Proportions, means and standard deviations, medians, quartiles, and ranges were calculated for the outcomes depending on continuous (e.g. number of llamas/alpacas) or categorical variables (e.g. age group or sex). Except for when specified in the first few questions, llamas and alpacas were combined for the survey. Baseline prevalences were calculated for diseases, malformations, and reproductive problems. Proportions were also calculated for the numbers of llamas and alpacas in Texas and how they were being used. When more than one answer was possible, then the total percentage of the responses could exceed 100 percent.

3.3.2 Univariate Analysis

All the data used in the univariate analysis was at the herd level. The dependent variables of interest included the diseases and reproductive problems, and independent (explanatory) variables included management and nutrition practices. Disease data was combined from adult males, adult females, and crias into one set of disease outcomes. If one or more animal was disease positive, then the herd was considered disease positive. Herd prevalence of diseases was calculated for each disease surveyed at the herd level. The number of disease positive farms was divided by the number of responding farms for each disease question. If a disease had a ten percent or greater prevalence then it became available for analysis.

Independent variables on management included: contact with other animals, housing, sources of feed, shearing, toenail trimming, vaccinations, insect control, manure removal, parasite control, and travel. Independent variables for nutrition included: water source, availability of pasture, supplementation, and access to feed by unwanted animals. Independent variables from the adult males, adult females, and crias needed to be combined or else the data would be spread to thin. In most the response for each group was the same across the management and nutrition questions. When responses differed between the 3 groups (male/female adults and crias), then new combined answer categories were created. In the case of the variable "primary shelter", the response that was most protective to the animal was used. Variables that had large amounts of missing data were recategorized by collapsing until further collapsing would result in no biological sense[37]

All continuous variables were categorized to become ordinal variables by using quantiles. When the continuous variable and the log odds of the dependent variable are not linear, then it is appropriate to categorize the variable. Continuous variables were categorized based on biologically meaningful cut points or divided into equal categories. Histograms were created to easily observe the equal-sized categories of the variable.

Associations between the categorical independent variables and the outcome variables were evaluated. Chi-square analysis or Fisher's Exact Test was used to test for association. In order for variables to undergo Chi-square analysis, there had to be no more than 20% of the variable groups with expected values less than five, as well as, no expected values less than one.[37] When these rules were not met, Fisher's was used for the evaluation.

3.3.3 Multivariable Analysis

Modeling was used to determine which associations were significant for specific diseases. The software program STATA[3] was used for statistical analysis. For an independent variable to be considered in the model, that variable's univariate test needed a p-value < 0.25.[38] Predictor variables that were too closely associated or collinear were not all used in trying to build the multivariable model. Only one variable from each group of collinear variables was selected for the model building and this was dependent on which one made the most biological sense or had the most significant univariate p-value.

[3] STATA 9, StataCorp LP, College Station, TX

A forwards stepwise selection method was used to determine which variables were added into the final model. Since there were a large number of potential predictors, forward selection modeling was appropriate because it would be difficult if not impossible to fit the full model while obtaining rational estimates.[37] Variables with the most significant p-values from the univariate analysis were added to the model first. A p-value less than or equal to 0.05 was considered significant for retention in the model. When all of the significant variables were added, then interaction terms were created. Any interaction terms with a p-value less than or equal to 0.05 was considered significant and the interaction sets were kept in the model. When the potential final model was completed, then dropped variables were added back into the model to assess that there would be no significant changes that might imply a confounder was present. The odds ratios were compared and if there was a 10% or greater difference then a confounder was likely to be present.

3.3.3 Spatial Analysis

Different spatial statistics were used to determine presence of disease clustering by county. The first question of the survey inquired about the herd's residence county. Chloropleth maps were constructed with ArcGIS[4] belowto show distributions of particular diseases and locations of farms by county. The number of farms per county was divided into categories. Counties with non-responders were not included in these categories but were noted on the legend as being neutral colored counties.

Spatial tests tend to lack power, so the use of multiple tests was needed to look for patterns of clustering. ArcGIS Spatial Tools[4] was used to run the spatial analysis tests. Moran's autocorrelation was used to measure spatial dependence of disease prevalence. Getis/Ord Gi* statistic was calculated using Hot Spot Analysis in ArcGIS. Then the G* statistic was compared to the mean of the study area to find high or low value clustering. The values were then determined to be significant or not at the 0.05 level.

Centroids were calculated for all counties using ArcGIS. The mean center of the Texas counties was found. A second mean center was found for when the information was weighted by the number of llama/alpaca farms, number of llamas/alpacas, or individual diseases. Standard deviational ellipses were created for each mean center both weighted and un-weighted.

[4] ArcGIS 9.0, ESRI Inc., Redlands, CA

IV. RESULTS

4.1 Response Rates

There were a total of 320 possible respondents when the member and former member lists were combined from the South Central Llama Association and Texas, Oklahoma, Louisiana, Arkansas, and New Mexico Alpaca Association (TxOLAN). Only TxOLAN members and former members with herds in Texas were included. Of these 320, there were 109 possible respondents with valid emails and/or addresses, who did not respond. In addition, 66 had an invalid or no email, 14 had an invalid or no mailing address, and 4 had an invalid email and invalid address. Nine respondents replied that they had no camelids in Texas. Table 4.1 shows the data related to respondents and non-respondents.

Table 4.1—Survey response rate information on the herd level.

Number of possible respondents	320
Total non-respondents*	-93
Valid potential respondents	227
Number of web survey responses	116
Number of mailed survey responses	+ 9
Total number of completed surveys	125
Response rate (125/227)	55%

*Invalid emails and invalid addresses, or response of no camelids.

4.2 Descriptive Statistics

The first question on the survey asked in which Texas County the camelid herd resides. Table 4.2 shows the full list of county responses from the survey. A total of 59 counties had responders with camelid herds. In a few instances two counties were given as a single response, indicating that the herd or farm crossed county lines. These counties were each given 0.5 values for those particular herds. Comal and Grimes counties had the most herds in this particular survey with eight herds each. Thirty-one counties not included in survey results where non-responders resided included: Anderson, Atacosa, Bell, Burleson, Cass, Coleman, Coryell, Delta, Eastland, El Paso, Ellis, Erath, Falls, Galveston, Jackson, Lee, Leon, Lubbock, Lynn, Medina, Midland, Polk, Rockwall, San Saba, Scurry, Somervell, Taylor, Van Zandt, Webb, Wood, and Young.

Table 4.2—Camelid herd's residential county. (N=125)*

County	N	(%)
Austin	3	(2)
Bandera	2	(2)
Bastrop	1	(1)
Bexar	3.5	(3)
Blanco	1	(1)
Bosque	1	(1)
Bowie	1	(1)
Brazoria	1	(1)
Brazos	3	(2)
Burnet	2	(2)
Caldwell	1	(1)
Cherokee	1	(1)
Collin	4	(3)
Colorado	1	(1)
Comal	8	(6)

Table 4.2 Continued.

County	N	(%)
Cooke	1	(1)
Crane	1	(1)
Denton	4	(3)
Fannin	1	(1)
Fayette	1	(1)
Fort Bend	1	(1)
Gillespie	2	(2)
Grayson	1	(1)
Grimes	8	(6)
Guadalupe	4	(3)
Hall	1	(1)
Hardin	0.5	(< 1)
Harris	2.5	(2)
Hays	7	(6)
Hill	1	(1)
Hood	1	(1)
Hopkins	1	(1)
Hunt	1	(1)
Jack	1	(1)
Jefferson	1	(1)
Johnson	5.5	(4)
Kendall	1.5	(1)
Kerr	1	(1)
Lamar	1	(1)
Lampasas	1	(1)
Llano	1	(1)
Milam	1	(1)
Montgomery	0.5	(< 1)
Morris	1	(1)
Nacogdoches	1	(1)
Navarro	1.5	(1)
Palo Pinto	1	(1)
Parker	5	(4)
Rusk	1	(1)
Smith	3	(2)
Tarrant	5.5	(4)
Tom Green	4	(3)
Travis	4	(3)
Victoria	2	(2)
Walker	1	(1)

Table 4.2 Continued.

County	N	(%)
Waller	2	(2)
Washington	1	(1)
Williamson	3	(2)
Wise	2	(2)

*No responses from 195 of 254 Texas counties.

There were a total of 2,079 camelids included in the survey. Fifty-four percent were adult females, 33% were adult males, and 14% were crias (< 9mos.). Camelid owners on average owned their animals for six years. The maximum number of years a respondent had camelids was 25 years. The minimum was one year.

Seventy-four percent of owners considered their llamas and alpacas as pet companions. Sixty-eight percent of owners had their camelids participate in shows and/or competitions. Wool production was an activity for 61% of camelid herds and their owners. Forty-one percent of owners used their camelids as guard animals. Pack animals (21%) and carting (3%) were also activities in which the owners' camelids participated. Sixteen percent of owners use their camelids in other activities, such as therapy animals, 4-H, pasture maintenance, and sport mascots. See Table 4.3 below.

Table 4.3—Camelid owner activities on the herd level.

Activity	N	(%)
Pet companion	92	(74)
Shows and/or competitions	85	(68)
Wool production	76	(61)
Guard animal	51	(41)
Pack animal	26	(21)

Table 4.3 Continued.

Activity	**N**	**(%)**
Carting	4	(3)
Other	20	(16)
Missing	0	(0)
Total	354	(N/A)

*More than one response possible per farm.

The majority of the llamas and alpacas in the herds surveyed were 3 to 15 years old. As can be seen in Table 4.4, there are approximately twice as many llamas as alpacas included in this survey.

Table 4.4—Camelids owned arranged into age groups at animal level. (N=2079)

Age	**Male**	**(%)**	**Female**	**(%)**	**Both**	**(%)**
Llamas						
< 9 mos.	90	(16)	59	(7)	149	(11)
9 mos.-2 yrs.	85	(15)	114	(14)	199	(14)
3-15 yrs.	364	(65)	632	(76)	996	(71)
> 15 yrs.	18	(3)	32	(4)	50	(4)
Total	557		837		1394	
Alpacas						
< 9 mos.	69	(24)	65	(16)	134	(20)
9 mos.-2 yrs.	86	(30)	91	(23)	177	(26)
3-15 yrs.	128	(45)	243	(60)	371	(54)
> 15 yrs.	0	(0)	3	(1)	3	(< 1)
Total	283		402		685	

The first set of questions on the survey did not specify age or sex of the camelids, and these questions were answered about the entire herd. Camelid owners obtained their health information about their animals through a variety of sources. Seventy-nine percent obtain health information by discussing with other owners. Seventy-four percent also obtained health information from their veterinarian. Reference books were used by 63% of camelid owners. Fifty-nine percent of owners used magazines and newsletters as a source of health information. The internet was used by 50% and 35% used association or industry meetings as a source of information. An additional two percent used some other source for health information. See Table 4.5.

Camelid toenail trimmings occurred on average two times per year. Alpacas and llamas were sheared on average once per year. Seventy-two percent of owners of male camelids had their fighting teeth removed. These numbers are presented in Table 4.5.

Llamas and alpacas were likely to come in contact with other domestic animals. Seventy percent had contact with dogs and 58% had contact with cats. A small percentage of camelids were reported to have contact with non-domestic animals, as can be seen in Table 4.5. Wildlife contact included raccoons at 48% and opossums at forty-three percent.

Table 4.5—Responses to the general section at the herd level. (N=125)

	N	**(%)**
Camelid health information*		
Other owners	99	(79)
Veterinarian	93	(74)
Reference books	79	(63)
Magazines/Newsletters	74	(59)
Internet	63	(50)
Assoc./Industry meetings	44	(35)
Other (ex. judges)	2	(2)
Missing	6	(5)
Total	460	(N/A)

Table 4.5 Continued.

	N	(%)
Toenail trimmings per year		
Minimum	0	
Median	2	
Maximum	20	
Missing	7	(6)
Shearings per year		
Median	1	
Missing	7	(6)
Fighting teeth removed		
Yes	78	(72)
No	31	(28)
Missing	8	(6)
Total	117	(100)
Domestic animal contact*		
Dogs	87	(70)
Cats	72	(58)
Horses	44	(35)
Cattle	31	(25)
Poultry	31	(25)
Goats	22	(18)
Sheep	4	(3)
Swine	0	(0)
Other (rabbits, donkeys)	12	(10)
None	8	(6)
Missing	6	(5)
Total	317	(N/A)
Non-domestic animal contact*		
Non-native deer species	4	(3)
Non-domestic bovids	2	(2)
Ratites	2	(2)
Antelope	1	(1)
Other	0	(0)
None	85	(68)
Missing	28	(22)
Total	122	(N/A)

Table 4.5 Continued.

	N	(%)
Wildlife contact*		
Raccoons	60	(48)
Opossum	54	(43)
Deer	47	(38)
Coyotes	44	(35)
Bobcats	15	(12)
Feral swine	12	(10)
Mountain lions	2	(2)
Other (armadillos, squirrels, rabbits, skunks, turkeys, foxes)	22	(18)
None	26	(21)
Missing	9	(7)
Total	291	(N/A)

*More than one response possible per farm.

The general nutrition questions found that the majority of owners obtained their concentrated feed from a retail source. Hay and/or alfalfa were obtained through a retail source by only 41% of camelid owners. Thirty-five percent of owners reported that rodents had access to their feed storage. Cats and/or dogs had access to 28% of the owners' feed storage. See Table 4.6.

Table 4.6—Responses to the general nutrition section at the herd level. (N=125)

	N	(%)
Concentrated feed		
Retail source	90	(72)
Bulk delivery	9	(7)
Home grown	2	(2)
Other (neighbors, friends, other llama owners)	11	(9)
None	2	(2)
Missing	11	(9)
Total	125	(100)

Table 4.6 Continued.

	N	(%)
Hay/Alfalfa		
Retail source	51	(41)
Bulk delivery	27	(22)
Home grown	20	(16)
Other (neighbors, friends)	15	(12)
None	4	(3)
Missing	8	(6)
Total	125	(100)
Feed storage access*		
Rodents	68	(35)
Cats/Dogs	55	(28)
Wild birds/Poultry	32	(17)
Other (rabbits, squirrels, raccoons, opossum, snakes)	4	(2)
None	34	(18)
Missing	9	(7)
Total	202	(N/A)

*More than one possible response per farm.

Responses to the general preventive care questions can be found below in Table 4.7. Forty-six percent of owners kept handwritten records for their llama and/or alpaca herds. Eighty-two percent of camelid owners reported that they vaccinated their animals, with 74% of the owners giving the injections themselves. The majority of the vaccinations are obtained from a veterinarian or feed/vet supply store. The top three vaccinations reported were CDT, rabies, and CONVAC 7-way or 8-way. Reasons for not vaccinating included: animals are contained, never had a problem, expensive, and no proven benefit.

Seventy-two percent of owners used an option of insect control. Sixty percent of these owners used an insect control spray. Parasite testing was done by 58% of owners.

Dewormers were used by 78% of herd owners. Eighty-five percent of these owners deworm as a general preventive.

Table 4.7—Responses to the general preventive care section at the herd level. More than one response per farm possible.

	N	**(%)**
Record keeping (N=125)		
Handwritten	57	(46)
Computerized	38	(30)
Maintained by veterinarian	12	(10)
Other (boarding rancher)	2	(2)
None	7	(6)
Missing	9	(1)
Total	120	(100)
Manure removal (N=125)		
Weekly	37	(30)
Daily	33	(26)
Monthly	18	(14)
Other (never, varies, couple times per year)	23	(18)
Missing	14	(11)
Total	125	(100)
Vaccinate (N=125)		
Yes	103	(82)
No	11	(9)
Missing	11	(9)
Total	125	(100)
	N	(%)
Injections are given by* (N=103)		
Owner	76	(74)
Veterinarian	36	(35)
Other (another llama owner, agisting rancher)	8	(8)
Missing	1	(1)
Total	121	(N/A)
Vaccines obtained from (N=103)		
Veterinarian	40	(39)
Feed/Vet supply store	37	(36)
Catalogue	12	(12)
Internet	8	(8)
Other	4	(4)
Missing	2	(2)
Total	103	(100)

Table 4.7 Continued.

	N	(%)
Vaccination type* (N=103)		
CDT	61	(59)
Rabies	40	(39)
CONVAC 7-way or 8-way	31	(30)
Tetanus toxoid	21	(20)
Leptospirosis 5-way	13	(13)
Vitamins A&D	9	(9)
BO-SE Selenium/Vitamin E	5	(5)
Missing	2	(2)
Total	182	(N/A)
Insect control (N=125)		
Yes	90	(72)
No	26	(21)
Missing	9	(7)
Total	125	(100)
Type of insect control* (N=90)		
Spray	54	(60)
Pour-on	15	(17)
Other (fly traps, fly predators, fly tags, mosquito dunks, garlic powder)	37	(41)
Missing	2	(2)
Total	108	(N/A)
Parasite testing (N=125)		
Yes	72	(58)
No	42	(34)
Missing	11	(9)
Total	125	(100)
Types of parasite tests* (N=72)		
Fecal egg reduction	34	(47)
Eggs per gram	18	(25)
Drench Rite	6	(8)
Baermann	4	(6)
Other (unknown, centrifuge)	19	(26)
Missing	2	(3)
Total	83	(N/A)
Use dewormers (N=125)		
Yes	97	(78)
No	18	(14)
Missing	10	(8)
Total	125	(100)

Table 4.7 Continued.

	N	(%)
Reason for deworming* (N=97)		
General preventative	82	(85)
Positive fecal test	18	(19)
Worms seen	7	(7)
Parasitic illness in herd	4	(4)
Other	0	(0)
Missing	0	(0)
Total	111	(N/A)
Type of dewormer used* (N=97)		
Ivermectin	73	(75)
Fenbendazole	35	(36)
Albendazole	19	(20)
Moxidectin	12	(12)
Pyrantel	3	(3)
Levamisole	1	(1)
Drug Combination	4	(4)
Other (Cydectin, Dectomax, Doramectin, Safeguard, Valbazen, Panacur)	29	(30)
Missing	0	(0)
Total	176	(N/A)

CDT = Combination Diphtheria & Tetanus

*More than one possible response per farm.

The majority of the camelid owners breed their animals. The most popular breeding strategy was appointment breeding at 79%. Percentages for other breeding strategies can be found in Table 4.8 below.

Table 4.8—Responses to the general reproduction section on herd level.

	N	(%)
Owners who breed camelids (N=125)		
Yes	97	(78)

Table 4.8 Continued.

	N	(%)
No	18	(14)
Missing	10	(8)
Total	125	(100)
Breeding strategy* (N=97)		
Appointment breeding	77	(79)
Pen breeding	16	(16)
Field breeding	14	(14)
Other (unspecified)	1	(1)
Missing	0	(0)
Total	108	(N/A)

*More than one response possible per farm.

Many of the owners travel with their camelids. The number one reason for travel is for shows and competitions. Veterinary health services are the number two reason for traveling. The median distance traveled is 325 miles and the maximum distance is 3,000 miles. Additional information on travel can be found below in Table 4.9.

Table 4.9—Responses to the general travel section.

	N	(%)
Travel times per year (N=125)		
1-2 times	31	(25)
3-4 times	25	(20)
5-10 times	35	(28)
11-20 times	7	(6)
21+ times	1	(1)
None	16	(13)
Missing	10	(8)
Total	125	(100)

Table 4.9 Continued.

	N	(%)
Reason for travel* (N=99)		
Show/Competition	76	(77)
Veterinary/Health services	51	(52)
Breeding	40	(40)
Recreation/Pack animal	18	(18)
Other (parades, boarding, sale delivery, shearing, public relations, relocating)	23	(23)
Missing	0	(0)
Total	208	(N/A)
Maximum distance traveled		
Minimum	5 miles	
Median	325 miles	
Maximum	3000 miles	

*More than one response possible per farm.

There were 115 farms that had male camelids and 113 farms that had female camelids in this survey. Male and female camelids were very similar when examining owner housing preferences for their animals (see Table 4.10). The median acreage for males was 4 acres and 6 acres for females. Maximum (500 acres) and minimum (1 acre) acreage was the same for both sexes. Woven wire was the preferred material for fences for males and females. The most used shelter types for males were 3-sided sheds and barns or stables for females.

Table 4.10—Adult camelid housing preferences on animal level. More than one response possible.

	Male (%)	Female (%)
Acreage		
Median	4	6
Maximum	500	500

Table 4.10 Continued.

	Male (%)	Female (%)
Minimum	1	1
Fence type *	N=115	N=113
Woven wire	90 (78)	89 (79)
Barbed wire	17 (15)	17 (15)
Wooden	13 (11)	12 (11)
Electric	8 (7)	9 (8)
Other (cattle panels, vinyl 4-rail, pipe)	14 (12)	16 (14)
Total	142 (N/A)	143 (N/A)
Primary shelter	N=115	N=113
Barn/Stable	30 (26)	45 (40)
3-sided shed	32 (28)	26 (23)
Trees	12 (10)	11 (10)
2-sided shed	6 (5)	8 (7)
1-sided shed	10 (9)	7 (6)
Other (tarps, lean-to, carport, covered dog run)	8 (7)	8 (7)
Missing	17 (15)	8 (7)
Total	115 (100)	113 (100)

*More than one response possible per farm.

Responses to adult camelid nutrition were divided into four categories: males, non-lactating/non-pregnant females, lactating females, or pregnant females (see Table 4.11). The preferred sources of water for male camelids were trough/bucket and automatic waterer. Females were similar with trough/bucket and automatic waterer. Pasture availability was the same for both sexes. Hay was the most used supplement for pasture with males, females, lactating females, and pregnant females. The two most common vitamin and mineral supplements were commercial mineral mix and salt licks.

Table 4.11—Adult camelid nutrition preferences at the herd level.

	Male (%)		Female (%)		Lactating Female (%)		Pregnant Female (%)	
Water source*	N=115		N=113					
Trough/Bucket	73	(63)	73	(65)				
Automatic waterer	45	(39)	53	(47)				
Pond/Reservoir/Tank	8	(7)	10	(9)				
Stream/Spring/River	3	(3)	1	(1)				
Other	1	(1)	0	(0)				
Pasture available	N=115		N=113					
Yes	97	(84)	100	(89)				
No	5	(4)	5	(4)				
Missing	13	(11)	8	(7)				
Supplements*	N=115		N=113		N=97		N=95	
Hay	82	(71)	85	(75)	76	(78)	73	(77)
Concentrate	56	(49)	61	(54)	29	(30)	28	(29)
Other (llama chews, rabbit pellets, oats, beet pulp, corn)	10	(9)	14	(12)	43	(44)	42	(44)
None	3	(3)	3	(3)	2	(2)	5	(5)
Vitamin/Mineral supplements*	N=115		N=113		N=97		N=95	
Commercial mineral mix	71	(62)	76	(67)	70	(72)	68	(72)
Salt lick	24	(21)	23	(20)	21	(22)	20	(21)
Calcium	3	(3)	4	(4)	3	(3)	3	(3)
Magnesium	4	(4)	4	(4)	4	(4)	4	(4)
Selenium	5	(4)	4	(4)	4	(4)	4	(4)
Vitamin E	3	(3)	4	(4)	3	(3)	4	(4)
Copper	4	(4)	3	(3)	3	(3)	3	(3)
Sodium	3	(3)	3	(3)	3	(3)	3	(3)
Zinc	4	(4)	3	(3)	3	(3)	3	(3)
Phosphorus	3	(3)	2	(2)	3	(3)	2	(2)
Chloride	1	(1)	1	(1)	1	(1)	1	(1)
Other (goat block, horse supplement, calf manna, herbs, fiber)	9	(8)	11	(10)	19	(20)	14	(15)
None	8	(7)	13	(12)	6	(6)	7	(7)

*More than one response possible per farm.

Adult camelid diseases and disorders can be found below in Table 4.12. It should be noted that because the disease related questions were at the end of the survey, many of the web-based survey responses did not finish this section. In other words, the amount of missing data increased. The most prevalent neurological disease found in these camelids was West Nile virus. Four cases in males and six cases in females affected approximately 1% of the entire adult population sampled. Eight percent of the population sampled had cases of mites with the majority of known mite types being *Sarcoptes*. Zinc-responsive skin disease was found in 3% of the sampled population, and 1% suffered from skin allergies.

One percent of the adult camelids had chronic watery eyes. Overgrowth of their incisors affected 7% of camelids. Thirteen percent had cases of otitis with the majority of these being females. Intestinal parasites were found in 14% of all camelids, while colic was reported in two percent. Six percent of camelids suffered from heat stress and 1% each suffered from Vitamin E-Se Deficiency and megaesophagus.

Table 4.12—Adult camelid diseases and disorders on the animal level.

	Male	**(%)** **N=681**	**Female**	**(%)** **N=1115**	**Total**	**(%)** **N=1796**
<u>Neurological</u>						
West Nile Virus	4	(1)	6	(1)	10	(1)
Veterinarian Diagnosis					2	
Diagnostic Lab Diagnosis					1	
Owner Diagnosis					0	
Encephalitis	0	(0)	2	(0.2)	2	(0.1)
Veterinarian Diagnosis					2	
Diagnostic Lab Diagnosis					0	
Owner Diagnosis					0	
Berserk Male Syndrome	4	(1)	-		4	(0.2)
Meningeal worm	1	(0.2)	3	(0.3)	4	(0.2)
Veterinarian Diagnosis					2	
Diagnostic Lab Diagnosis					0	
Owner Diagnosis					0	

Table 4.12 Continued

	Male	**(%)**	**Female**	**(%)**	**Total**	**(%)**
	N=681		**N=1115**		**N=1796**	
Tetanus	4	(1)	1	(0.1)	5	(0.3)
Veterinarian Diagnosis					1	
Diagnostic Lab Diagnosis					0	
Owner Diagnosis					0	
Rabies	4	(1)	0	(0)	4	(0.2)
<u>Skin</u>						
Skin allergies	0	(0)	18	(2)	18	(1)
Veterinarian Diagnosis					2	
Diagnostic Lab Diagnosis					0	
Owner Diagnosis					3	
Mites	44	(6)	106	(10)	150	(8)
Sarcoptes	31	(5)	7	(1)	38	(2)
Chorioptes	3	(0.4)	1	(0.1)	4	(0.2)
Psoroptes	0	(0)	0	(0)	0	(0)
Unknown	10	(1)	31	(3)	41	(2)
Veterinarian Diagnosis					18	
Diagnostic Lab Diagnosis					0	
Owner Diagnosis					6	
Zinc-responsive skin disease	14	(2)	31	(3)	45	(3)
Veterinarian Diagnosis					11	
Diagnostic Lab Diagnosis					2	
Owner Diagnosis					5	
Malignant edema	0	(0)	0	(0)	0	(0)
<u>Skeletal</u>						
Extra toes	5	(1)	0	(0)	5	(0.3)
Fused toes	4	(1)	0	(0)	4	(0.2)
<u>Eyes</u>						
Chronic watery eyes	4	(1)	11	(1)	15	(1)
Blind	0	(0)	6	(1)	6	(0.3)
Cataracts	0	(0)	1	(0.1)	1	(0.1)
Ectropian eyelids	0	(0)	1	(0.1)	1	(0.1)
Entropian eyelids	0	(0)	1	(0.1)	1	(0.1)
<u>Mouth/Jaw</u>						
Incisor overgrowth	41	(6)	81	(7)	122	(7)
Excessive salivation	0	(0)	4	(0.4)	4	(0.2)
Overdeveloped upper jaw	3	(0.4)	1	(0.1)	4	(0.2)
Underdeveloped lower jaw	1	(0.2)	2	(0.2)	3	(0.2)
<u>Ears</u>						
Otitis	31	(5)	207	(19)	238	(13)
Veterinarian Diagnosis					6	
Diagnostic Lab Diagnosis					1	
Owner Diagnosis					5	
Deaf	0	(0)	3	(0.3)	3	(0.2)

Table 4.12 Continued

	Male N=681	(%)	Female N=1115	(%)	Total N=1796	(%)
Gastrointestinal						
Intestinal parasites	75	(11)	178	(16)	253	(14)
Veterinarian Diagnosis					36	
Diagnostic Lab Diagnosis					6	
Owner Diagnosis					14	
Colic	14	(2)	28	(3)	42	(2)
E. coli infection	1	(0.2)	7	(1)	8	(0.5)
Veterinarian Diagnosis					10	
Diagnostic Lab Diagnosis					2	
Owner Diagnosis					5	
Bovine Viral Diarrhea	0	(0)	0	(0)	0	(0)
Other						
Heat stress	37	(5)	77	(7)	114	(6)
Vitamin E-Se deficiency	5	(1)	12	(1)	17	(1)
Veterinarian Diagnosis					6	
Diagnostic Lab Diagnosis					2	
Owner Diagnosis					0	
Megaesophagus	2	(0.3)	9	(1)	11	(1)
Veterinarian Diagnosis					5	
Diagnostic Lab Diagnosis					2	
Owner Diagnosis					0	
Liver flukes	2	(0.3)	5	(0.5)	7	(0.4)
Veterinarian Diagnosis					5	
Diagnostic Lab Diagnosis					0	
Owner Diagnosis					3	
Mycotoxicosis	1	(0.2)	1	(0.1)	2	(0.1)
Veterinarian Diagnosis					0	
Diagnostic Lab Diagnosis					1	
Owner Diagnosis					0	
Johne's Disease	0	(0)	1	(0.1)	1	(0.1)
Listeriosis	0	(0)	1	(0.1)	1	(0.1)
S. pyogenes infection	0	(0)	1	(0.1)	1	(0.1)

Twenty-three percent of male and forty percent of female adult camelids in this survey were bred. Sixty-two percent of owners who owned males and 67% of owners who owned females breed their camelids. The median age when camelids were bred for the first time was the same for both sexes at 2 years old. The oldest first time bred age for males was 10 years and for females was 14 years. These numbers can be found below in Table 4.13.

Table 4.13—Reproduction and breeding in adult camelids.

	Male (%)	**Female (%)**
	N=681	N=1115
Number of camelids bred	154 (23)	449 (40)
Number of owners who breed camelids (N=125)	78 (62)	84 (67)
Age when bred for 1st time		
Median	2	2
Maximum	10	14
Minimum	< 1	1

Fifty-three percent of the adult males were left intact. Of these intact males, 18% were kept separated from the rest of the herd. Two percent of males were reported to be uninterested in breeding, 2% had a poor sperm count, 1% had an inability to ejaculate, and 1% had undescended testes. See below in Table 4.14.

Table 4.14—Reproduction in adult male camelids.

	Male (%)
Intact/Gelded males (N=681)	
Number of intact	361 (53)
Number of gelded	138 (20)
Missing	182 (27)
Total	681 (100)
Intact males kept separated (N=361)	
Yes	64 (18)
No	14 (4)
Missing	283 (78)
Total	361 (100)

Table 4.14 Continued.

	Male	**(%)**
Reproductive problems (N=681)*		
Uninterested in breeding	16	(2)
Poor sperm count	14	(2)
Inability to ejaculate	10	(1)
Undescended testes	7	(1)
Total	47	(N/A)

*More than one possible response per farm.

Fourteen percent of the pregnancies in the past year resulted in abortions and 6% resulted in stillbirths. Only 80% of the pregnancies resulted in successful cria births. The major female reproductive problems were metritis affecting 6%, low milk production (4%), and follicular cysts (2%). Mastitis, prolapsed uteri, and rejected crias each affected 1% of the population. See Table 4.15.

Table 4.15—Reproduction in individual adult female camelids (N=1115).

	Female	**(%)**
Camelid pregnancies in past year (N=364)		
Abortions	50	(14)
Stillbirths	21	(6)
Crias born	293	(80)
Reproductive problems (Number of females bred=1115)*		
Metritis	70	(6)
Veterinarian Diagnosis	4	
Diagnostic Lab Diagnosis	0	
Owner Diagnosis	1	
Low milk production	47	(4)
Follicular cysts	17	(2)
Veterinarian Diagnosis	6	
Diagnostic Lab Diagnosis	0	
Owner Diagnosis	0	

Table 4.15 Continued.

	Female	**(%)**
Mastitis	12	(1)
Veterinarian Diagnosis	4	
Diagnostic Lab Diagnosis	0	
Owner Diagnosis	4	
Prolapsed uterus	10	(1)
Veterinarian Diagnosis	4	
Diagnostic Lab Diagnosis	0	
Owner Diagnosis	1	
Rejected cria	6	(1)
Caesarian section	5	(0.5)
Uterine torsion	4	(0.4)
Veterinarian Diagnosis	2	
Diagnostic Lab Diagnosis	0	
Owner Diagnosis	1	
Immature ovary	3	(0.3)
Veterinarian Diagnosis	1	
Diagnostic Lab Diagnosis	0	
Owner Diagnosis	0	
Imperforated hymen	2	(0.2)
Veterinarian Diagnosis	1	
Diagnostic Lab Diagnosis	0	
Owner Diagnosis	0	
Chlamydia	1	(0.1)
Veterinarian Diagnosis	1	
Diagnostic Lab Diagnosis	0	
Owner Diagnosis	0	
Undeveloped vagina	1	(0.1)
Veterinarian Diagnosis	1	
Diagnostic Lab Diagnosis	0	
Owner Diagnosis	0	
Total	178	(N/A)

*More than one possible response per farm.

Only 122 of the farms indicated they had crias and had the opportunity to participate in this portion of the survey. Thirty-two percent of crias were born in open pasture and 16% were born in enclosures specifically for pregnant females and newborns. Twenty-nine percent of owners indicated they waited less than an hour between the birth and handling the newborn cria. The majority of owners did not request a veterinary exam during the crias' first month. The primary shelter most often provided for crias was a barn, stable or a 3-sided shed. See Table 4.16.

Fifty-three percent of the crias had pasture available. Hay was the most used pasture supplement. Commercial mineral mix and salt licks were the most used vitamin and mineral supplements. Selenium was also noted as given to crias by three owners.

Table 4.16—Cria general care at the herd level.

	Crias	**(%)**
Birth place (N=122)		
Open pasture	39	(32)
Pregnant females/newborn enclosure	20	(16)
Enclosure with other camelids	12	(10)
Other	0	(0)
Missing	51	(42)
Total	122	(100)
Time between birth & handling (N=122)		
< 1 hour	35	(29)
1-8 hours	25	(21)
9-24 hours	3	(3)
2-3 days	2	(2)
4-7 days	1	(1)
> Week	3	(3)
Missing	53	(43)
Total	122	(100)

Table 4.16 Continued.

	Crias	(%)
Vet exam during 1st month (N=122)		
Yes	16	(13)
No	54	(44)
Missing	52	(43)
Total	122	(100)
Access to shelter (N=122)		
Yes	67	(55)
No	3	(3)
Missing	52	(43)
Total	122	(100)
Primary shelter (N=122)		
Barn/Stable	33	(27)
3-sided shed	16	(13)
1-sided shed	6	(5)
2-sided shed	5	(4)
Trees	3	(3)
Other	4	(3)
Missing	55	(45)
Total	122	(100)
Water source* (N=122)		
Trough/Bucket	46	(38)
Automatic waterer	35	(29)
Pond/Reservoir/Tank	5	(4)
Stream/Spring/River	0	(0)
Other	0	(0)
Total	86	(N/A)
Pasture Available (N=122)		
Yes	65	(53)
No	4	(3)
Missing	53	(43)
Total	122	(100)
Supplements* (N=122)		
Hay	51	(42)
Concentrate	19	(16)
Other (calf manna, rabbit pellets, oats, beet pulp, corn)	17	(14)
None	9	(7)
Total	96	(N/A)

Table 4.16 Continued.

	Crias	**(%)**
Vitamin/Mineral supplements* (N=122)		
Commercial mineral mix	51	(42)
Salt lick	8	(7)
Selenium	3	(3)
Calcium	1	(1)
Magnesium	1	(1)
Phosphorus	1	(1)
Sodium	1	(1)
Vitamin E	1	(1)
Zinc	1	(1)
Chloride	0	(0)
Copper	0	(0)
Other	6	(5)
None	8	(7)
Total	82	(N/A)

*More than one response possible per farm.

Cria diseases and disorders can be found below in Table 4.17. Ventricular septal defect was found in 1% of the crias included in the survey. Eleven percent of the crias had cases of mites, all from *Sarcoptes*. The retention of toe caps occurred in 2% of crias. One percent of crias had cataracts. Two percent of crias had an absence of erupted incisors and one percent had wry face. Otitis affected 18% and one percent was deaf. Intestinal parasites were reported in 16 percent of the crias. Megaesophagus and colic each occurred in one percent of the crias.

Cryptorchidism affected 1% of the cria population sampled. Twenty-one percent of the crias were born premature. Nineteen percent of crias were reported to be weak and 11% had a poor suckling reflex. Two percent suffered from heat stress and one percent had choanal atresia.

Table 4.17—Cria diseases and disorders at the animal level. (N=283)

	Crias	(%)
Heart		
Ventricular septal defect	2	(1)
PDA	0	(0)
Neurological		
Undeveloped cerebellum	0	(0)
West Nile Virus	0	(0)
Encephalitis	0	(0)
Rabies	0	(0)
Tetanus	0	(0)
Meningeal worm	1	(0.4)
Skin		
Skin allergies	1	(0.4)
Mites	30	(11)
Sarcoptes	30	(11)
Chorioptes	0	(0)
Psoroptes	0	(0)
Unknown	0	(0)
Zinc-responsive skin disease	1	(0.4)
Malignant edema	0	(0)
Skeletal		
Retention of toe caps	6	(2)
Extra toes	1	(0.4)
Fused toes	0	(0)
Eyes		
Cataracts	2	(1)
Blind	0	(0)
Ectropian eyelids	0	(0)
Entropian eyelids	0	(0)
Mouth/Jaw		
Absence of erupted incisors	7	(2)
Wry face	2	(1)
Underdeveloped lower jaw	1	(0.4)
Excessive salivation	0	(0)
Overdeveloped upper jaw	0	(0)
Overgrowth of incisors	0	(0)
Ears		
Otitis	50	(18)
Deaf	2	(1)

Table 4.17 Continued.

	Crias	(%)
Gastrointestinal		
Intestinal parasites	46	(16)
Colic	2	(1)
Mega esophagus	2	(1)
Atresia ani	1	(0.4)
E. coli infection	1	(0.4)
Bovine Viral Diarrhea	0	(0)
Reproductive		
Cryptorchidism	2	(1)
Hermaphroditism	0	(0)
Other		
Premature	60	(21)
Weak	53	(19)
Poor suckling reflex	32	(11)
Heat stress	7	(2)
Choanal atresia	3	(1)
Vitamin E-SE deficiency	1	(0.4)
Johne's Disease	0	(0)
Listeriosis	0	(0)
Mycotoxicosis	0	(0)
S. pyogenes infection	0	(0)

PDA = Patent Ductus Arteriosus

4.3 Univariate Analysis

Univariate analysis was used with eight outcome variables which had a 10% or greater prevalence at the herd level. These outcome variables were zinc-responsive skin disease, chronic watery eyes, skin allergies, mites, intestinal parasites, incisor overgrowth, heat stress, and colic.

Seven of the 39 possible independent variables with significantly associated with zinc-responsive skin disease at 0.25. These variables were breeding, breeding system type, deworming reason, parasite testing, type of parasite testing, maximum distance traveled, and how many years owned. Table 4.18 shows the univariate analysis for zinc-responsive disease.

Table 4.18—Univariate analysis for outcome variable "zinc responsive".

		Zinc-Responsive Skin Disease			
		No	Yes	X^2	P-value
Parasite Testing (N=111)	No	39	3		
	Yes	55	14		
	Total	94	17	3.83	0.05
Breeding Type (N=113)	Other Only	34	2		
	Appointment & Other	7	1		
	Appointment Only	55	14		
	Total	96	17	4.62	0.10
Deworm Reason (N=107)	Do Not Deworm	14	3		
	General Preventative Only	61	7		
	Other Only	7	2		
	General Preventative & Other	8	5		
	Total	90	17	5.90	0.12
Years Owned (N=113)	1-3 years	29	3		
	4-6 years	22	3		
	7-12 years	25	9		
	13+ years	20	2		
	Total	96	17	4.74	0.19
Breed Camelids (N=113)	No	16	1		
	Yes	80	16		
	Total	96	17	1.59	0.21
Maximum Distance Traveled (N=112)	0-50 miles	27	3		
	51-299 miles	20	6		
	300-599 miles	26	2		
	600+ miles	22	6		
	Total	95	17	4.28	0.23

There were 12 independent variables associated with chronic watery eyes at p=0.25. See Table 4.19. These independent variables were the source of feed, deworming reason, type of dewormer, contact with domestic animals, type of fencing, insect control type, where vaccines were obtained, vaccination type, vitamin supplements, contact with wildlife, travel, and how often toenails are trimmed.

Table 4.19—Univariate analysis for outcome variable “watery”.

		Chronic Watery Eyes			
		No	**Yes**	**X^2**	**P-value**
Feed Source (N=111)	Retail	75	11		
	Other	24	1		
	Total	99	12	1.88	0.17
Deworm Reason (N=107)	Do Not Deworm	17	0		
	General Preventative Only	62	6		
	Other Only	7	2		
	General Preventative & Other	10	3		
	Total	96	11	6.71	0.08
Domestic Animal Contact (N=113)	None	8	0		
	Dog/Cat Only	29	2		
	Dog/Cat & Other	54	10		
	Other Only	10	0		
	Total	101	12	3.83	0.15
Fence Type (N=97)	Woven Only	53	5		
	Other Only	8	0		
	Woven & Other	32	7		
	Total	93	12	1.83	0.18
Insect Control Type (N=94)	Do Not Use	21	2		
	Spray Only	35	3		
	Other Only	26	7		
	Spray & Other	15	0		
	Total	97	12	3.11	0.21
Vaccination Type (N=108)	Not Vaccinated	11	0		
	Clostridium/CDT Only	40	2		
	Clostridium/CDT & Other	39	9		
	Other Only	6	1		
	Total	96	12	7.20	0.07

Table 4.19 Continued.

		Chronic Watery Eyes			
		No	**Yes**	**X^2**	**P-value**
Vitamin Supplements (N=95)	None	10	0		
	Commercial Mix Only	42	7		
	Commercial Mix & Other	31	5		
	Other Only	18	0		
	Total	101	12	2.87	0.24
Wildlife Contact (N=110)	None	28	0		
	Raccoon/Opossum Only	9	0		
	Raccoon/Opossum & Other	50	8		
	Other Only	11	4		
	Total	98	12	9.70	0.01
Travel (N=113)	None	14	1		
	1-2 Times	30	1		
	3-4 Times	23	2		
	5+ Times	34	8		
	Total	101	12	5.48	0.14
Toenail Trimmings (N=112)	0-3 times per year	65	5		
	4+ times per year	35	7		
	Total	100	12	2.40	0.12

There were 13 independent variables associated with skin allergies (Table 4.20). These variables were the source of hay, breeding system type, reason for deworming, type of dewormer, contact with domestic animals, who gives the vaccination, pasture supplements, number of shearings per year, what has access to feed storage, vaccination type, contact with wildlife, number of years owned, and number of acres used for camelids.

Table 4.20—Univariate analysis for outcome variable “skin allergies”.

		Skin Allergies No	Skin Allergies Yes	X^2	P-value
Attain Hay/Alfalfa	Retail	46	2		
	Other	54	10		
	Total	100	12	4.17	0.04
Breeding Type	Other Only	35	1		
	Appointment & Other	7	1		
	Appointment Only	58	10		
	Total	100	12	4.31	0.11
Deworm Reason	Do Not Deworm	17	0		
	General Preventative Only	59	8		
	Other Only	9	0		
	General Preventative & Other	10	3		
	Total	95	11	5.54	0.06
Domestic Animal Contact	None	8	0		
	Dog/Cat Only	28	2		
	Dog/Cat & Other	54	10		
	Other Only	10	0		
	Total	100	12	3.72	0.16
Pasture Supplements	None	5	0		
	Hay Only	17	1		
	Hay & Other	70	8		
	Other Only	7	3		
	Total	99	12	4.52	0.21
Shearing	Once per Year	84	7		
	Twice or More per Year	15	5		
	Total	99	12	4.19	0.04
Feed Storage Access	None	31	3		
	Rodents Only	16	1		
	Rodents & Other	42	4		
	Other Only	10	4		
	Total	99	12	4.21	0.24
Vaccination Type	Not Vaccinated	11	0		
	Clostridium/CDT Only	36	5		
	Clostridium/CDT & Other	41	7		
	Other Only	7	0		
	Total	95	12	3.10	0.21

Table 4.20 Continued.

		Skin Allergies			
		No	Yes	X^2	P-value
Wildlife Contact	None	27	1		
	Raccoon/Opossum Only	9	0		
	Raccoon/Opossum & Other	46	11		
	Other Only	15	0		
	Total	97	12	4.66	0.03
Years Owned	1-3 Years	31	1		
	4-6 Years	25	0		
	7-12 Years	28	6		
	13+ Years	16	5		
	Total	100	12	6.17	0.05

Sixteen independent variables were associated with mites. See Table 4.21 below. These variables were breeding system type, use of dewormer, reason for deworming, type of dewormer, insect control, type of insect control, contact with non-domestic animals, where vaccines obtained, type of camelids owned, parasite testing, type of parasite test, pasture supplements, shearings per year, vaccination type, travel, and number of years owned.

Table 4.21—Univariate analysis for outcome variable “mites”.

		Mites			
		No	Yes	X^2	P-value
Parasite Testing (N=111)	No	40	2		
	Yes	50	19		
	Total	90	21	10.38	0.001
Non-Domestic Animal Contact (N=92)	No	71	15		
	Yes	2	4		
	Total	73	19	6.47	0.01

Table 4.21 Continued.

		Mites No	Mites Yes	X^2	P-value
Camelid Type Owned (N=112)	Llamas Only	65	9		
	Alpacas Only	17	11		
	Llamas & Alpacas	9	1		
	Total	91	21	9.29	0.01
Shearing (N=112)	Once per Year	71	20		
	Twice or More per Year	20	1		
	Total	91	21	4.21	0.04
Breeding Type (N=113)	Other Only	33	3		
	Appointment & Other	5	3		
	Appointment Only	54	15		
	Total	92	21	5.02	0.08
Dewormer Used (N=113)	No	16	1		
	Yes	76	20		
	Total	92	21	2.65	0.10
Insect Control (N=113)	No	23	2		
	Yes	69	19		
	Total	92	21	2.76	0.10
Pasture Supplement (N=112)	Do Not Supplement	4	1		
	Hay Only	17	1		
	Hay & Other	60	19		
	Other Only	10	0		
	Total	91	21	3.83	0.15
Travel (N=113)	None	12	3		
	1-2 Times	29	2		
	3-4 Times	19	6		
	5+ Times	32	10		
	Total	92	21	5.01	0.17
Vaccination Type (N=108)	Not Vaccinated	10	1		
	Clostridium/CDT Only	36	6		
	Clostridium/CDT & Other	35	13		
	Other Only	7	0		
	Total	88	20	3.30	0.19
Number of Years Owned	1-3 years	27	5		
	4-6 years	21	4		
	7-12 years	24	10		
	13+ years	20	2		
	Total	92	21	4.19	0.24

The outcome of intestinal parasites had 14 independent variables associated with it (Table 4.22). These variables were owner activity, breeding, breeding system, reason for deworming, type of dewormer, where owners obtain information, parasite testing, type of parasite tests, pasture supplements, primary shelter, fighting teeth removed, reason for travel, vitamin supplements, and travel.

Table 4.22—Univariate analysis for outcome variable "intestinal parasites".

		Intestinal Parasites			
		No	**Yes**	**X^2**	**P-value**
Owner Activity (N=112)	Wool/Show & Other	37	35		
	Wool/Show Only	15	4		
	Other Only	19	2		
	Total	71	41	14.61	0.0007
Breed Camelids (N=112)	No	14	2		
	Yes	57	39		
	Total	71	41	5.38	0.02
Deworm Reason (N=107)	Do Not Deworm	11	6		
	General Preventative Only	51	17		
	Other Only	3	6		
	General Preventative & Other	3	10		
	Total	68	39	16.32	0.001
Owner Information Sources (N=111)	Meetings/Owners & Vet & Other	40	31		
	Meetings/Owners & Other	11	3		
	Vet & Other	12	6		
	Other Only	7	1		
	Total	70	41	5.44	0.14
Parasite Testing (N=110)	No	33	9		
	Yes	37	31		
	Total	70	40	6.82	0.009
Primary Shelter (N=111)	Other	12	13		
	3-Sided Shed	21	8		
	Stall	37	20		
	Total	70	41	3.56	0.17

Table 4.22 Continued.

		Intestinal Parasites			
		No	Yes	X^2	P-value
Remove Fighting Teeth (N=110)	No Males	6	0		
	No	45	28		
	Yes	18	13		
	Total	69	41	5.92	0.05
Travel Reason (N=112)	Do Not Travel	12	3		
	Shows/Competitions Only	13	5		
	Other Only	20	3		
	Shows/Competitions & Other	26	30		
	Total	71	41	15.69	0.001
Vitamin Supplements (N=112)	None	10	0		
	Commercial Mix	25	24		
	Customized Mix	36	17		
	Total	71	41	15.26	0.002

Nine independent variables were associated with overgrowth of incisors (Table 4.23). These variables were owner activity, source of feed, source of hay, type of insect control, primary shelter, what had feed storage access, fighting teeth removed, vitamin supplements, and travel.

Table 4.23—Univariate analysis for outcome variable “incisor”.

		Incisor			
		No	Yes	X^2	P-value
Insect Control Type (N=109)	Do Not Use	19	4		
	Spray Only	34	4		
	Other Only	22	11		
	Spray & Other	9	6		
	Total	84	25	8.37	0.04

Table 4.23 Continued.

		Incisor			
		No	**Yes**	**X^2**	**P-value**
Vitamin Supplements (N=113)	None	10	0		
	Commercial Mix	40	9		
	Customized Mix	24	12		
	Other Only	14	4		
	Total	88	25	7.80	0.05
Feed Storage Access (N=112)	None	31	3		
	Rodents Only	14	4		
	Rodents & Other	31	15		
	Other Only	11	3		
	Total	87	25	6.93	0.07
Owner Activity (N=113)	Wool/Show & Other	53	20		
	Wool/Show Only	18	1		
	Other Only	17	4		
	Total	88	25	5.42	0.07
Remove Fighting Teeth (N=111)	No Males	7	0		
	No	58	15		
	Yes	22	9		
	Total	87	24	4.40	0.11
Hay/Alfalfa Source (N=113)	Retail	35	3		
	Other	53	22		
	Total	88	25	2.07	0.15
Travel (N=113)	None	11	4		
	1-2 Times	28	3		
	3-4 Times	17	8		
	5+ Times	32	10		
	Total	88	25	4.88	0.18
Primary Shelter (N=112)	Other	20	5		
	3-Sided Shed	20	10		
	Stall	48	9		
	Total	88	24	3.45	0.18
Feed Source (N=111)	Retail	69	17		
	Other	17	8		
	Total	86	25	1.57	0.21

There were 17 independent variables associated with heat stress. See Table 4.24. These were owner activity, breeding system, use of dewormers, reason for deworming, type of dewormer, owner information, insect control, type of insect control, separation of males, parasite testing, pasture supplements, fighting teeth removed, vaccinated, vaccine type, vitamin supplements, contact with wildlife, and travel.

Table 4.24— Univariate analysis for outcome variable “heat stress”.

		Heat Stress			
		No	**Yes**	**X^2**	**P-value**
Owner Activity (N=112)	Wool/Show & Other	40	32		
	Wool/Show Only	16	3		
	Other Only	18	3		
	Total	74	38	10.76	0.005
Breeding Type (N=112)	Other Only	24	11		
	Appointment & Other	2	6		
	Appointment Only	48	21		
	Total	74	38	6.11	0.05
Deworm Reason (N=107)	Do Not Deworm	14	3		
	General Preventative Only	47	21		
	Other Only	3	6		
	General Preventative & Other	6	7		
	Total	70	37	8.67	0.03
Owner Information Sources (N=111)	Meetings/Owners & Vet & Other	44	27		
	Meetings/Owners & Other	12	2		
	Vet & Other	10	8		
	Other Only	7	1		
	Total	73	38	6.09	0.11
Insect Control (N=112)	No	20	5		
	Yes	54	33		
	Total	74	38	2.98	0.08
Males Separated (N=77)	No	10	3		
	Yes	35	29		
	Total	45	32	2.33	0.13

Table 4.24 Continued.

		Heat Stress			
		No	Yes	X^2	P-value
Parasite Testing (N=110)	No	31	11		
	Yes	41	27		
	Total	72	38	2.14	0.14
Pasture Supplements (N=111)	Do Not Supplement	5	0		
	Hay Only	11	7		
	Hay & Other	49	29		
	Other Only	8	2		
	Total	73	38	5.64	0.13
Remove Fighting Teeth (N=110)	No Males	6	0		
	No	43	30		
	Yes	23	8		
	Total	72	38	7.53	0.02
Vaccination Type (N=107)	Not Vaccinated	5	5		
	Clostridium/CDT Only	32	10		
	Clostridium/CDT & Other	27	21		
	Other Only	6	1		
	Total	70	37	6.49	0.09
Vitamin Supplements (N=112)	None	9	1		
	Commercial Mix	33	16		
	Customized Mix	32	21		
	Total	74	38	4.48	0.21
Wildlife Contact (N=110)	None	25	3		
	Raccoon/Opossum Only	5	4		
	Raccoon/Opossum & Other	33	25		
	Other Only	9	6		
	Total	72	38	10.89	0.01
Travel (N=112)	None	11	4		
	1-2 Times	23	7		
	3-4 Times	17	8		
	5+ Times	23	19		
	Total	74	38	4.31	0.23

There were 21 independent variables associated with colic at p=0.25. See Table 4.25 below. These independent variables were owner activity, breeding system, use of dewormer, reason for deworming, type of dewormer, insect control, type of camelids owned, parasite testing, parasite testing type, primary shelter, fighting teeth removed, reason for travel, vaccinated, vaccination type, vitamin supplements, source of water, contact with wildlife, travel, number of years owned, acreage, and number of toenail trimmings per year.

Table 4.25— Univariate analysis for outcome variable "colic".

		Colic			
		No	Yes	X^2	P-value
Owner Activity (N=112)	Wool/Show & Other	52	21		
	Wool/Show Only	18	1		
	Other Only	17	3		
	Total	87	25	6.58	0.04
Breeding Type (N=112)	Other Only	28	7		
	Appointment & Other	4	4		
	Appointment Only	55	14		
	Total	87	25	3.21	0.20
Deworm Reason (N=106)	Do Not Deworm	16	1		
	General Preventative Only	53	14		
	Other Only	4	5		
	General Preventative & Other	9	4		
	Total	82	24	8.70	0.03
Insect Control (N=112)	No	22	3		
	Yes	65	22		
	Total	87	25	2.19	0.14
Camelid Type Owned (N=101)	Llamas Only	52	21		
	Alpacas Only	24	4		
	Llamas & Alpacas	10	0		
	Total	86	25	2.46	0.12
Parasite Testing (N=110)	No	38	4		
	Yes	47	21		
	Total	85	25	7.42	0.006
Primary Shelter (N=111)	Other	20	5		
	3-Sided Shed	18	12		
	Stall	48	8		
	Total	86	25	7.09	0.03

Table 4.25 Continued.

		Colic			
		No	Yes	X^2	P-value
Remove Fighting Teeth (N=110)	No Males	7	0		
	No	50	23		
	Yes	28	2		
	Total	85	25	12.24	0.002
Vaccination Type (N=100)	Not Vaccinated	10	1		
	Clostridium/CDT Only	33	8		
	Clostridium/CDT & Other	32	16		
	Other Only	7	0		
	Total	82	25	4.19	0.12
Vitamin Supplements (N=112)	None	10	0		
	Commercial Mix	36	13		
	Customized Mix	41	12		
	Total	87	25	5.94	0.11
Water Source (N=111)	Trough	31	16		
	Automatic Waterer	26	3		
	Other	1	0		
	More Than One	29	6		
	Total	87	25	6.78	0.03
Wildlife Contact (N=100)	None	25	3		
	Raccoon/Opossum Only	9	0		
	Raccoon/Opossum & Other	40	17		
	Other Only	11	4		
	Total	85	24	4.28	0.12
Travel (N=112)	None	14	0		
	1-2 Times	27	4		
	3-4 Times	20	5		
	5+ Times	26	16		
	Total	87	25	14.25	0.003
Number of Years Owned (N=112)	1-3 years	30	2		
	4-6 years	21	4		
	7-12 years	21	12		
	13+ years	15	7		
	Total	87	25	11.20	0.01
Number of Acres (N=112)	1-3 acres	31	5		
	4-6 acres	17	5		
	7-12 acres	20	11		
	13+ acres	19	4		
	Total	87	25	4.76	0.19

Table 4.25 Continued.

		Colic			
		No	Yes	X^z	P-value
Toenail Trimmings (N=)	0-3 times per year	50	19		
	4+ times per year	36	6		
	Total	86	25	2.76	0.10

4.4 Multivariable Analysis

Modeling was performed with the eight dependent variables that were common health issues on the herd level. These eight dependent variables were zinc responsive-skin disease, chronic watery eyes, skin allergies, mites, intestinal parasites, heat stress, colic, and incisor overgrowth. Multivariable models could be constructed for only five of these eight independent variables because there were no independent variables associated at the 0.05 p-value level.

Some of the independent variables needed to be excluded to avoid collinearity. These variables were from sets of nested questions in the survey. Each set of dewormer, insect control, vaccine-related, and parasite control variables were reduced to the single variable with the most significant p-value from the univariate analysis before being introduced into the logistic regression.

The first logistic regression model was used to determine associations of skin allergies in Texas camelids. The only variable retained in the final model was shearings per year. See Table 4.26 below.

Table 4.26—Final logistic regression model for predictors of skin allergies in Texas camelids (N=111).

Variable	Categories	Odds Ratio	95% CI	
Shearing	Once per Year	1.0	….	LR x^2=4.19
	2 or More per Year	4.0	1.1, 14	Prob > x^2=0.04

The second logistic regression model was used to determine predictors of mites in Texas camelids (Table 4.27). The only variables retained in the final model were parasite testing and contact with non-domestic animals. Interaction terms were not successfully added because the model became unstable.

Table 4.27—Final logistic regression model for predictors of mites in Texas camelids (N=90).

Variable	Categories	Odds Ratio	95% CI	
Parasite Testing	No	1.0	….	LR x^2=16.12
	Yes	7.0	1.3, 36	Prob > x^2=0.0003
Non-Domestic Animal Contact	No	1.0	….	
	Yes	20	1.7, 240	

The third logistic regression model was used to determine predictors of intestinal parasites in Texas camelids (Table 4.28). The only variables retained in the final model were deworming reason and reason for travel. Interaction terms were not successfully added to the model.

Table 4.28—Final logistic regression model for predictors of intestinal parasites in Texas camelids (N=107).

Variable	Categories	Odds Ratio	95% CI	
Deworming Reason	Do Not Deworm	1.0	….	LR x^2=28.72
	General Preventative Only	0.7	0.2, 2.5	Prob > x^2=0.0001
	Other Only (worms seen, etc.)	4.1	0.6, 28	
	Gen. Prev. & Other	5.7	1.0, 32	
Travel Reason	Do Not Travel	1.0	….	
	Shows Only	2.1	0.4, 12	
	Other Only (vet, breeding, etc.)	0.3	0.04, 2.6	
	All Reasons	3.4	0.8, 14	

The fourth logistic regression model was used to determine predictors of heat stress in Texas camelids (Table 4.29). The only variable retained in the final model was owner activity.

Table 4.29—Final logistic regression model for predictors of heat stress in Texas camelids (N=65).

Variable	Categories	Odds Ratio	95% CI	
Owner Activity	Wool/Show & Other	1.0	….	LR x^2=7.31
	Wool/Show Only	0.2	0.03, 0.9	Prob > x^2=0.03
	Other	0.3	0.05, 1.4	

The last logistic regression model was used to determine predictors of colic in Texas camelids (Table 4.30). The only variables retained in the final model were parasite testing and number of years owned. Interaction terms were not successfully added to the model.

Table 4.30—Final logistic regression model for predictors of colic in Texas camelids (N=110).

Variable	Categories	Odds Ratio	95% CI	
Parasite Testing	No	1.0	….	LR x^2=18.66
	Yes	4.6	1.4, 15	Prob > x^2=0.0009
Years Owned	1-3 Years	1.0	….	
	4-6 Years	4.8	0.8, 31	
	7-12 Years	9.5	1.9, 48	
	13+ Years	8.1	1.5, 46	

4.5 Spatial Analysis

4.5.1 Counties

The gray counties in Figure 4.1 are counties where survey respondents keep their camelid herds. The majority of theses counties lie in central and eastern Texas. Tan counties were not represented by any llama farms in this survey.

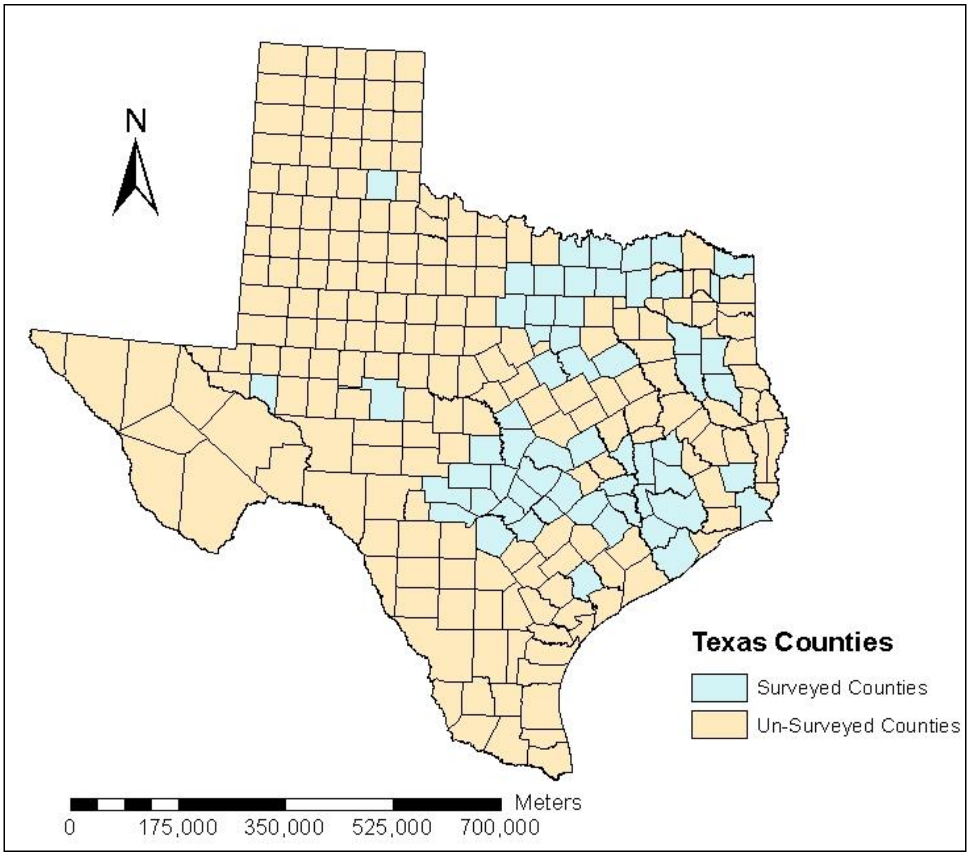

Figure 4.1—Counties with and without survey responses.

4.5.2 Camelid and Farms Distributions

A map showing the break up of camelids by male-female-cria classifications is shown in Figure 4.2. Each pie chart represents a county with camelid farms included in this survey. Most counties appear to contain predominantly female herds.

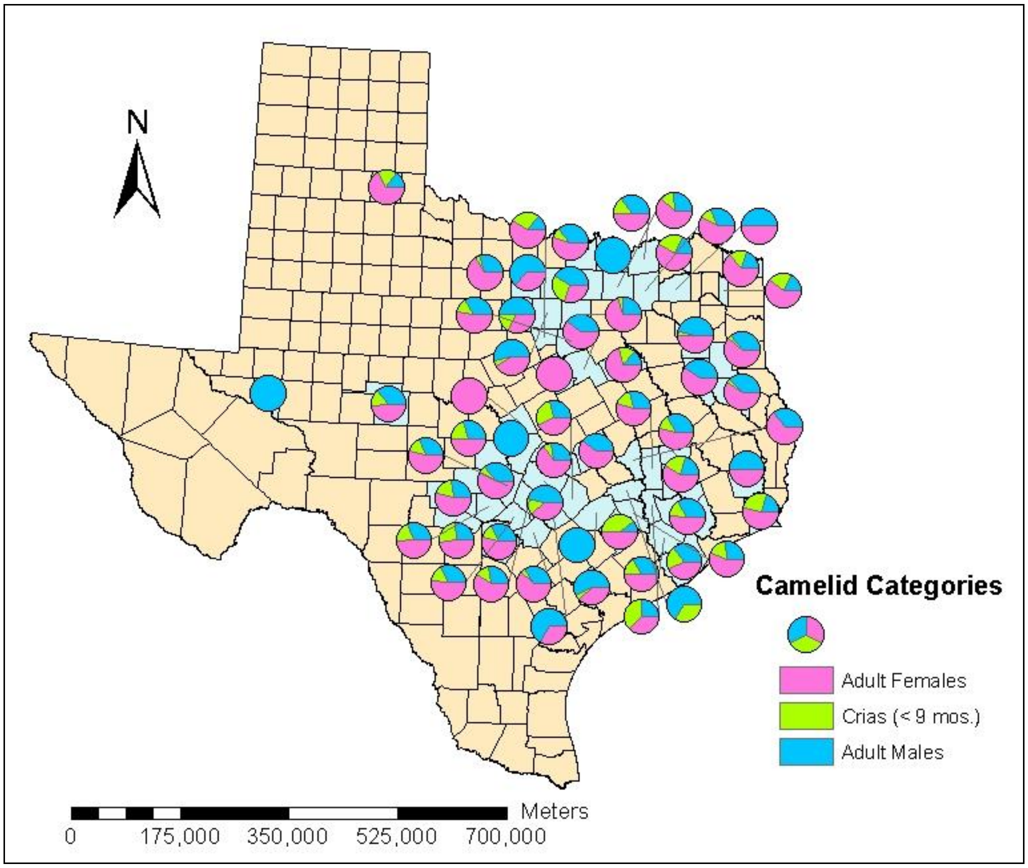

Figure 4.2—Distributions of three age/sex camelid categories over counties surveyed.

Figure 4.3 shows the number of camelids distributed throughout the counties. Yellow counties only had 1 to 3 known camelids. The counties continue to get more orange and eventually red as the number of camelids increase. The darkest red counties have between 101 and 172 camelids.

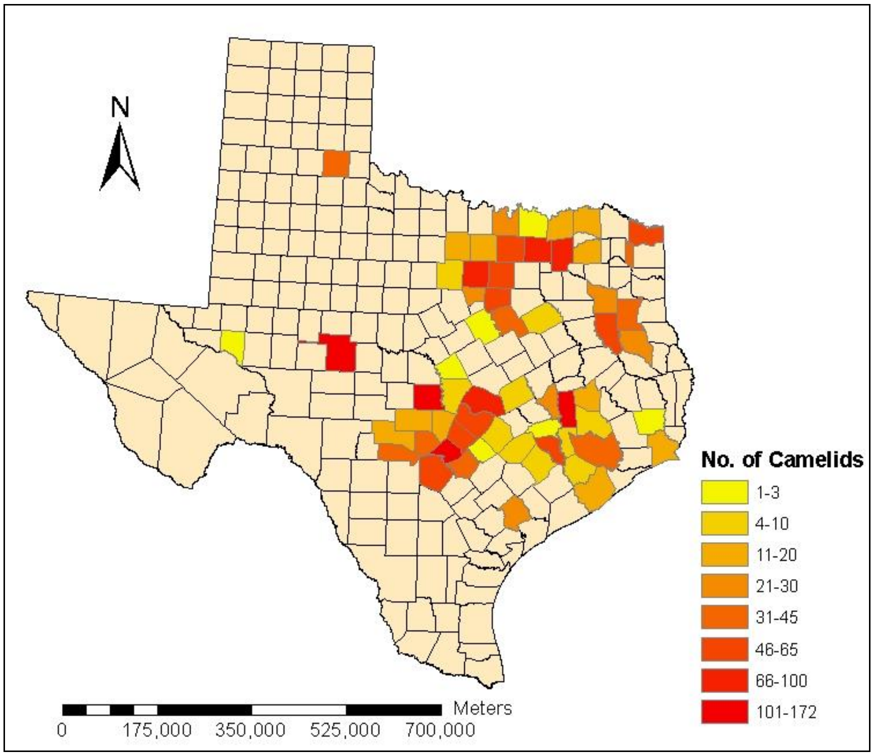

Figure 4.3—Number of camelids per county.

Figure 4.4 shows the number of camelid farms distributed throughout the counties. The number of farms per county range from one to eight. Yellow counties had the fewest farms and red counties have the most farms.

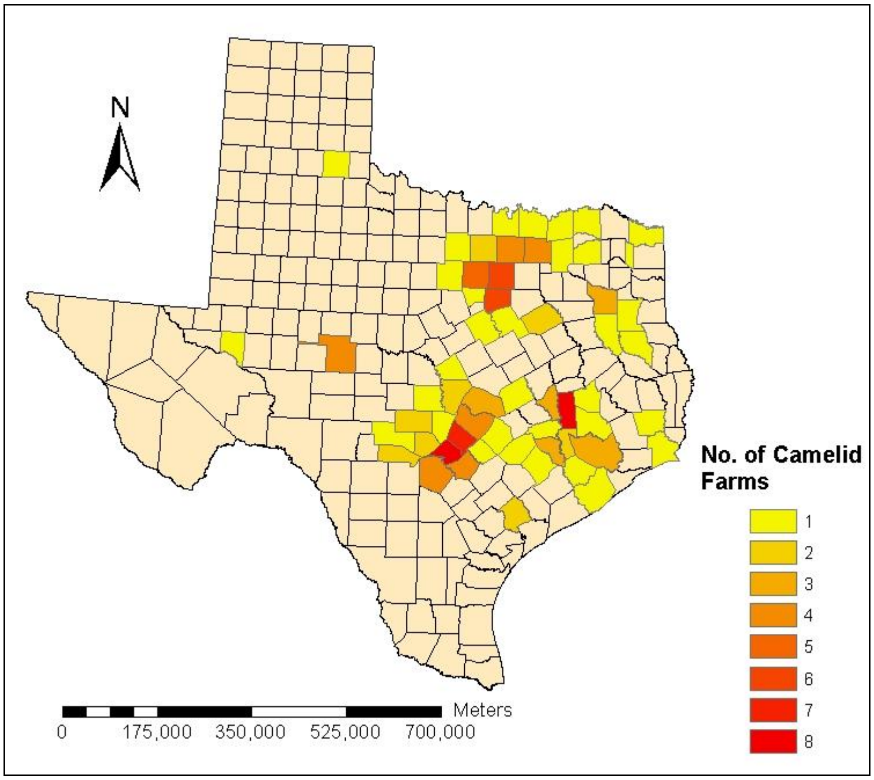

Figure 4.4—Number of camelid farms per county.

In the following figure (Figure 4.5), the number of camelids were divided by the number of farms for each county. The average density of camelids per farm are represented by red counties that increase in color intensity as the proportion increases.

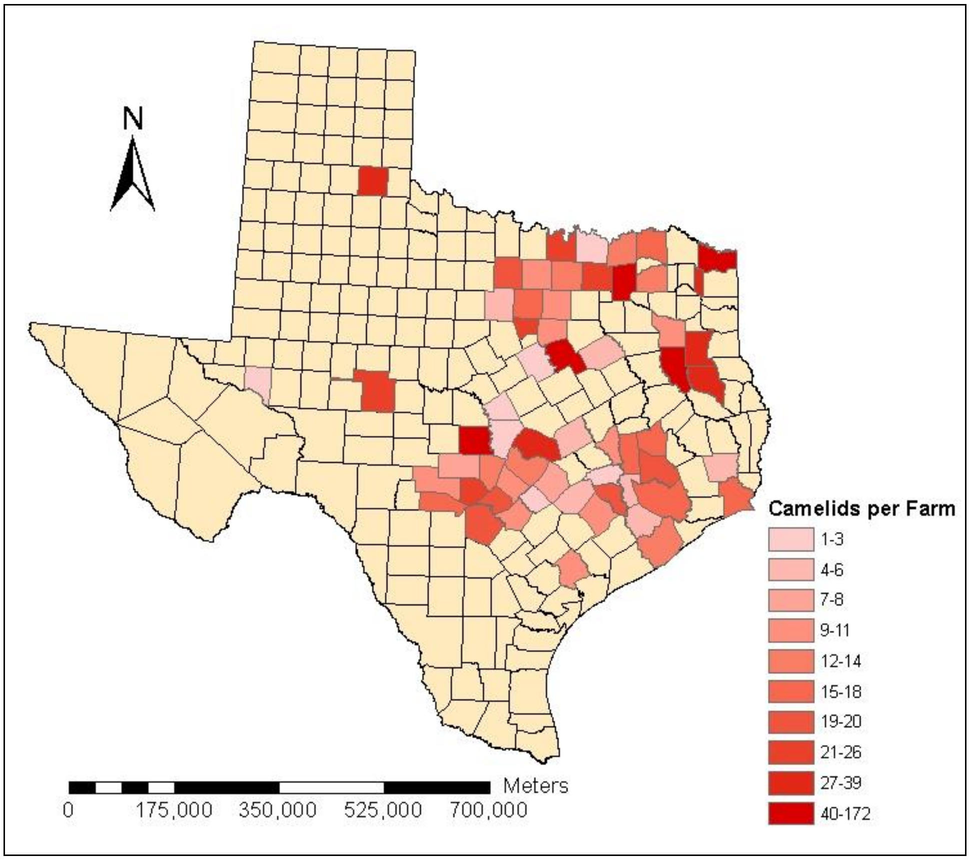

Figure 4.5—Number of camelids per farm by county.

The Local Moran's I statistics were calculated to assess clustering and displayed in Figure 4.6. The statistics ranged from -1.912 to 1.120. A Moran's I near +1.00 indicates clustering while a value near -1.00 indicates dispersion. A Global Moran's spatial autocorrelation of camelids per county showed a Moran's I Index of -0.04 with a z-score of -0.9 standard deviations, indicating neither clustering nor dispersion. However, a Global Moran's spatial autocorrelation of camelid farm per county showed a Moran's I Index of 0.01 with a z-score of 1.6 standard deviations. This indicates there may be a possible clustering of farms by counties significant at the 0.10 level, although there is 5-10% likelihood that this is the result of random chance.

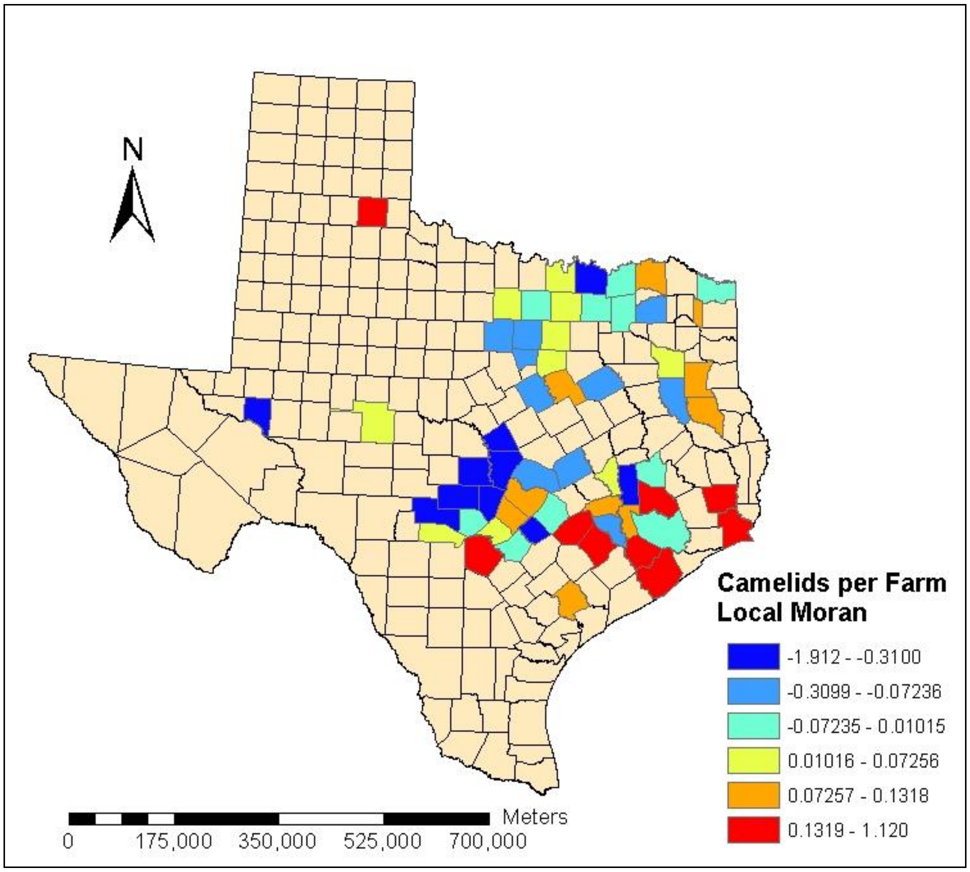

Figure 4.6—Local Moran of camelids per farm.

A map of Hot Spot Analysis on camelids per county can be seen in Figure 4.7. Hot Spot Analysis uses the Getis/Ord Gi* statistic to find z-scores for each feature. The z-score represents a statistical significance of clustering as the value moves away from zero. The general G index for camelids per county was zero with a z-score of 0.6 standard deviations, indicating no clustering.

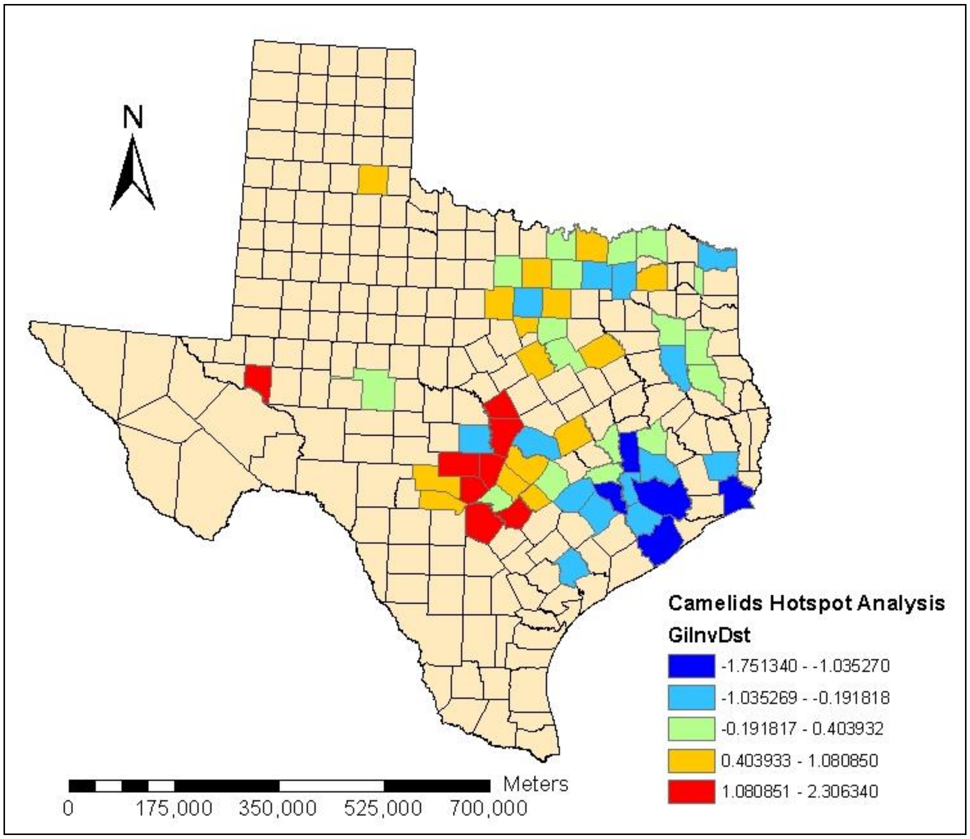

Figure 4.7—Camelid hot spot analysis.

A map of Hot Spot Analysis on camelid farms per county can be seen in Figure 4.8. The general G index was equal to zero with a z-score of 3.2 standard deviations. Clustering of farms was found to be significant at the 0.01 level. The ArcGIS program reported that there was less than 1% likelihood that the clustering of high values could be the result of random chance.

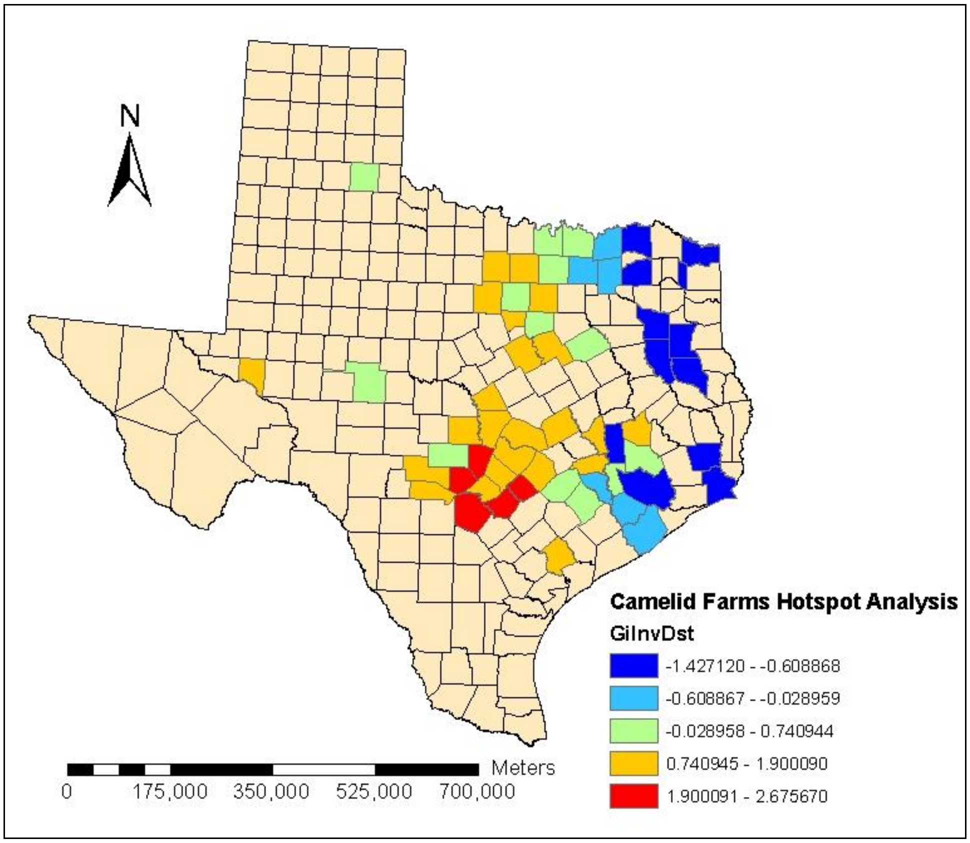

Figure 4.8—Camelid farms hot spot analysis.

Figure 4.9 shows a comparison of mean centers and standard distance ellipses when the numbers of camelids per county were or were not proportioned by farms. All three mean centers shift to the right when the numbers of camelids are proportioned by the number of farms. This shift may indicate that while there may be larger groups of camelids spreading to the northwest, the majority of the camelid farms are towards the southeast. The standard ellipse for crias becomes smaller indicating a greater cria per farm concentration around the newly proportioned mean center. The same is true for females when the numbers of farms are considered. The ellipse for males not proportioned by farms is oblong, extending from the northwest to the southeast. However, when divided by the number of farms, the ellipse takes a similar circular shape as the crias and females. This means that when the number of males is not divided by farms, then there is an uneven spread of male camelids across the state.

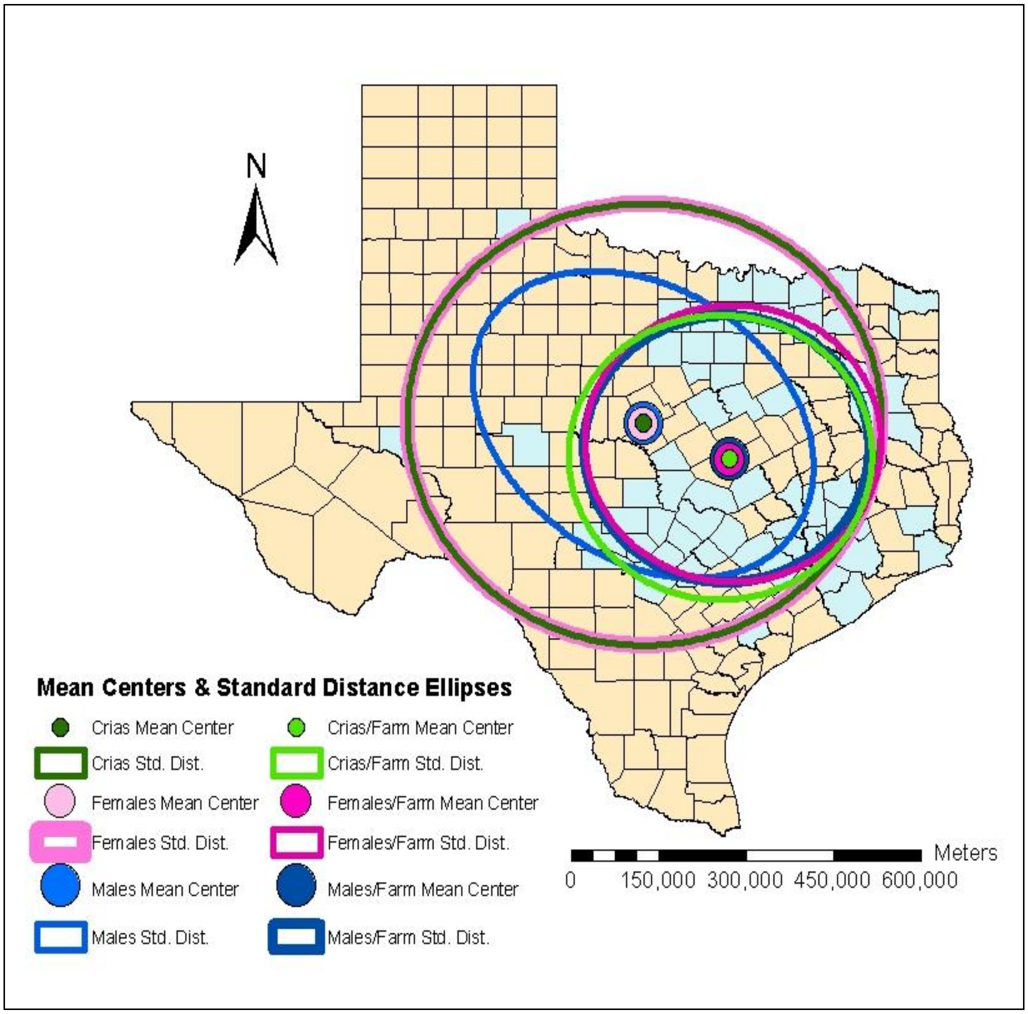

Figure 4.9—Mean distances and standard distance ellipses.

4.5.3 Camelid Activities

A map displaying camelid activities by county is below in Figure 4.10. Each county is represented by a pie chart showing the percentage of owners who participate in certain camelid activities. A majority of camelid owners consider their animals as companion pets which can be seen by the many green pie pieces on the map. A colored piece not often seen is the pink for owners who participate in carting.

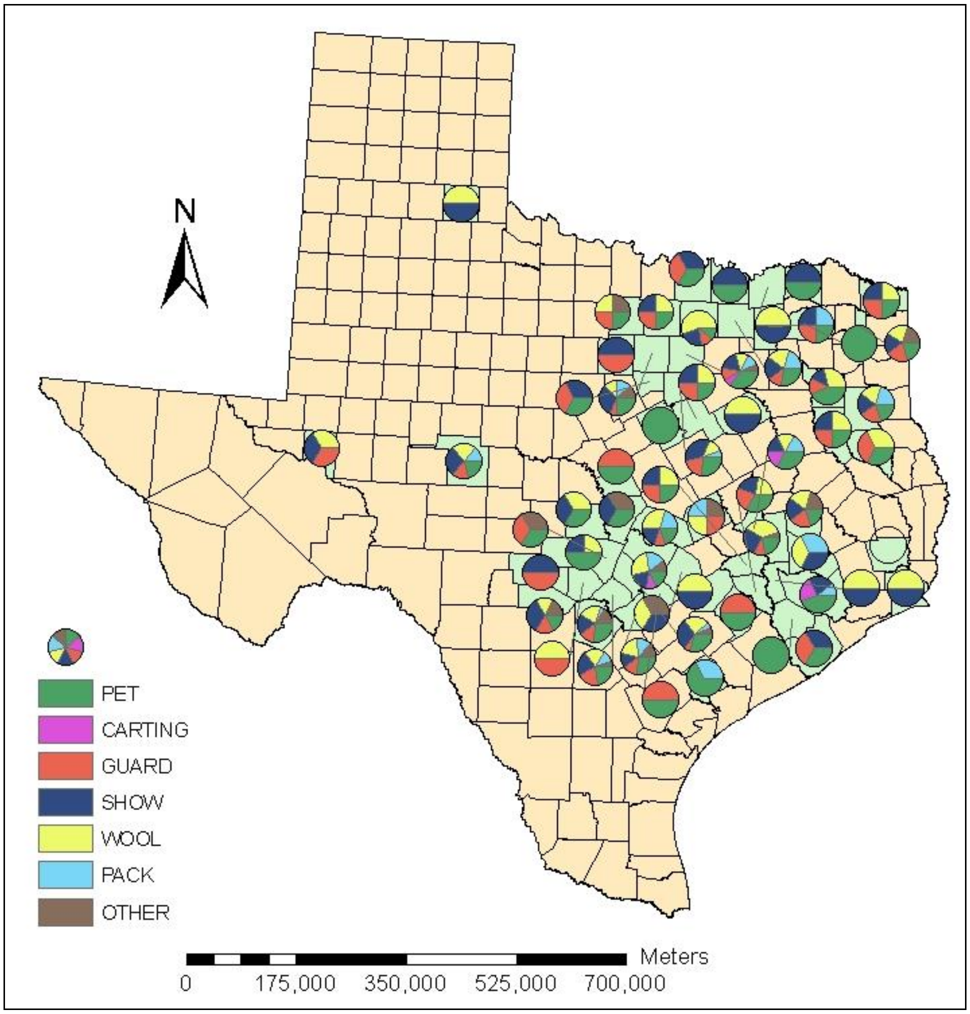

Figure 4.10—Distributions of camelid activities by county.

Pets and Companions. Figure 4.11 shows the distribution of owners who consider their camelids as pets of companion animals. Counties that were included in the survey by respondents, but had no owners who participated in particular activities, are shown in white. Red and orange counties contain the most owners who consider their camelids to be pets or companions.

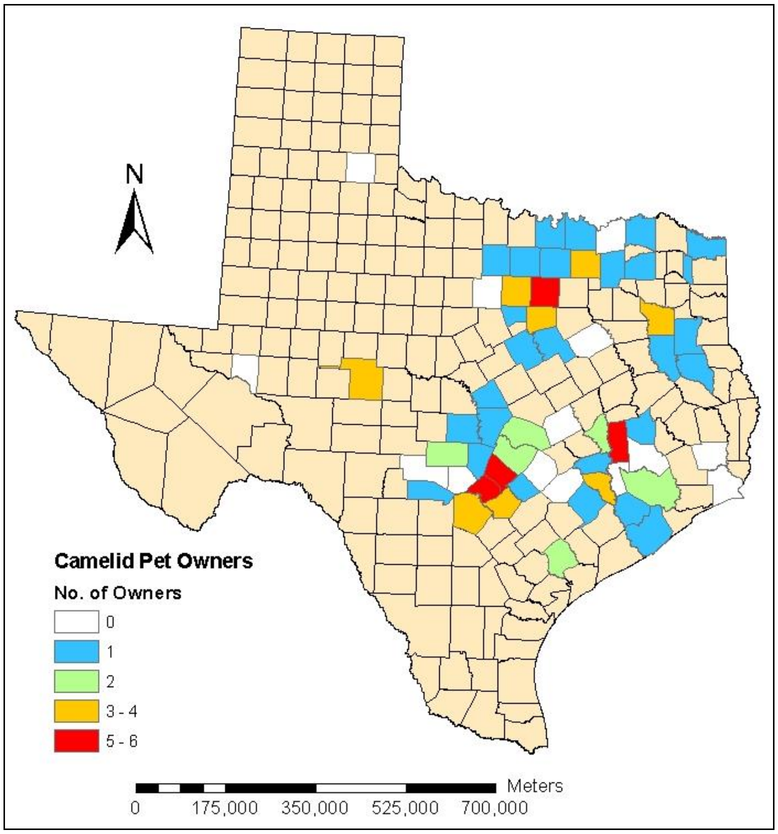

Figure 4.11—Number of camelid pet owners by county.

Shows and Competitions. The following map displays the number of owners who participate in shows or competitions with their camelids. In Figure 4.12, there six counties with 4 or more owners who participate in shows.

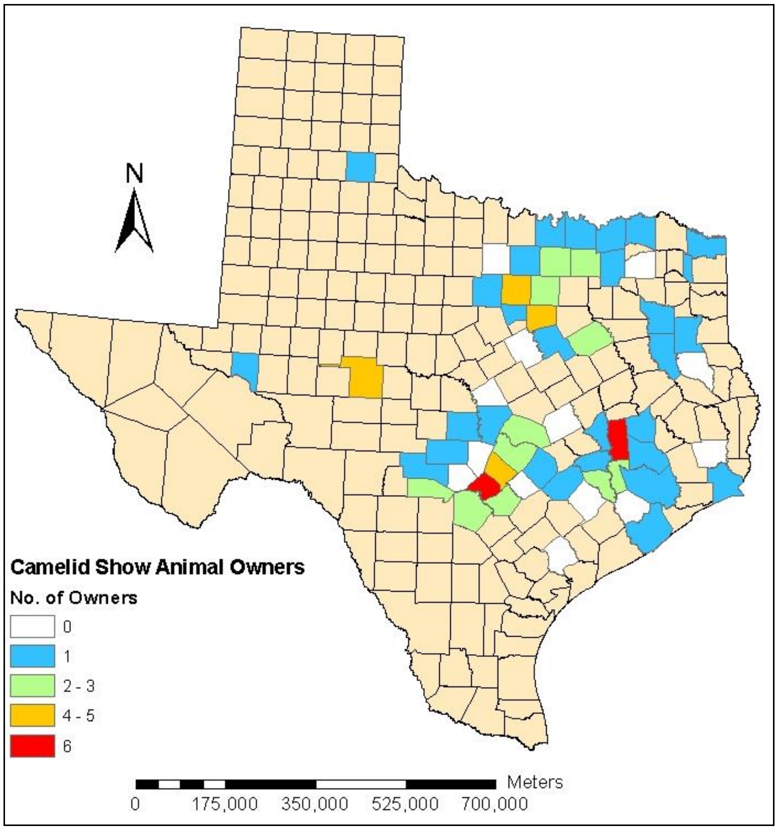

Figure 4.12—Number of camelid show animal owners by county.

Wool Producers. Figure 4.13 shows owners who use their camelids for wool production. The majority of the counties within the survey only had 1 to 3 owners who participated in wool production.

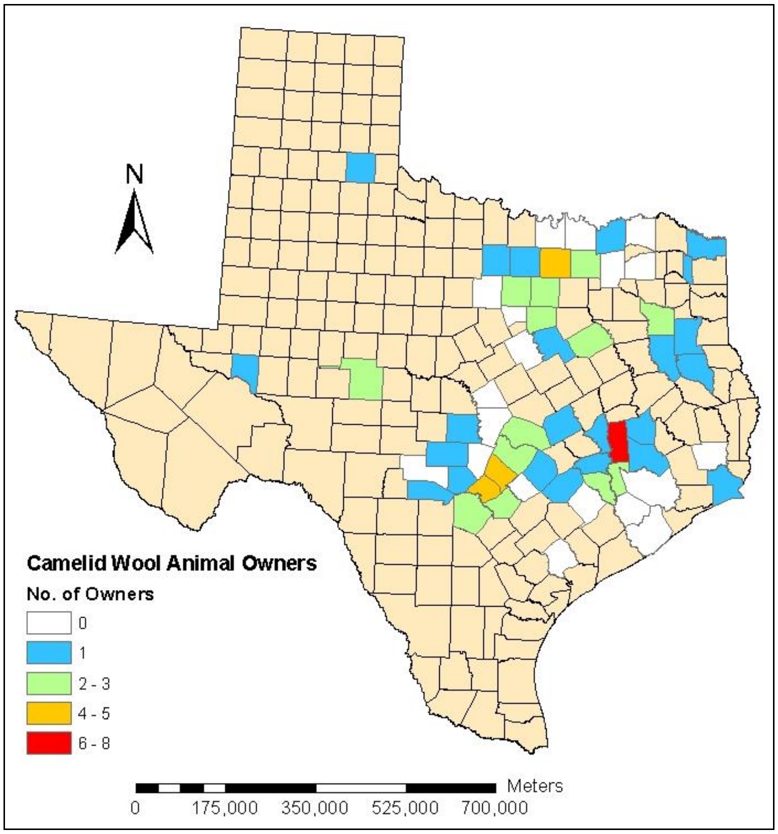

Figure 4.13—Number of camelid wool animal owners by county.

Guard Animals. The distribution of owners who use camelids as guard animals can be found in Figure 4.14. Except for two counties all other counties had 2 or less owners that used their camelids as guard animals. The two remaining counties had 3 and 5 owners using guard llamas.

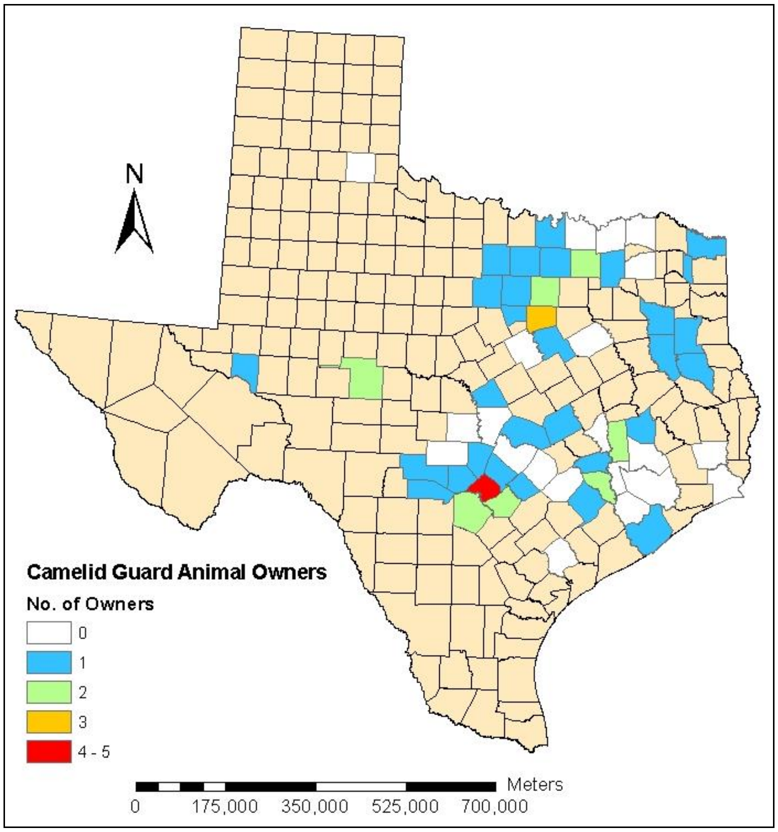

Figure 4.14—Number of camelid guard animal owners by county.

Pack Animals. Figure 4.15 below, shows owners that use their llamas or alpacas as pack animals. Fewer counties had owners that participated in this activity than previously mentioned activities. Counties surveyed were found to have between zero and three owners who used their camelids as pack animals.

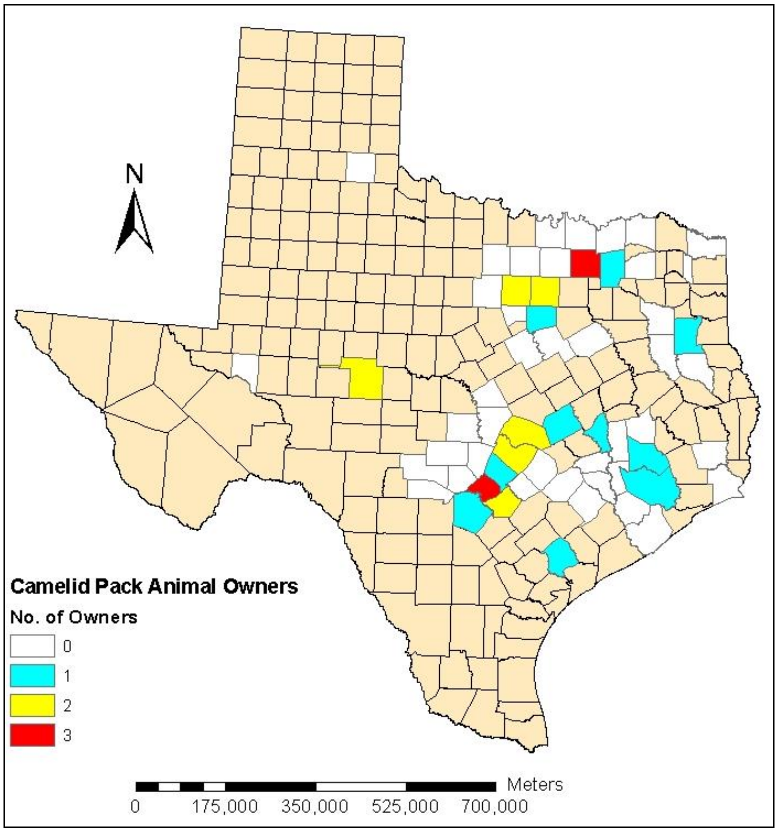

Figure 4.15—Number of camelid pack animal owners by county.

Carting. The last activity to be mapped out was camelid carting, as can be seen in Figure 4.16. Very few owners participate in carting within the Texas counties included in the survey. Only four owners with one each of four counties used their llamas or alpacas for carting.

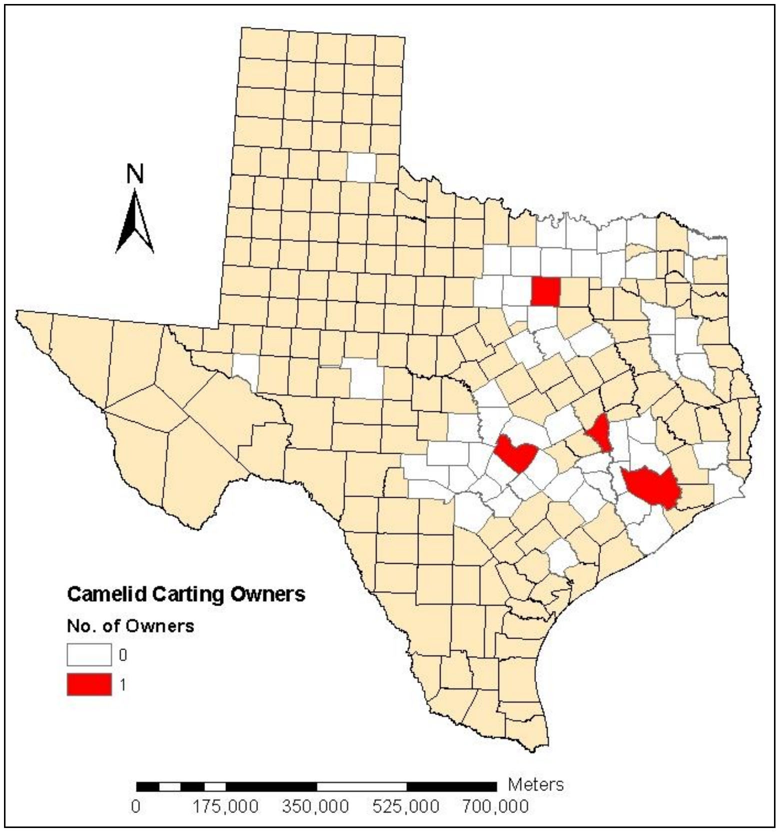

Figure 4.16—Number of camelid carting owners by county.

4.5.4 Adult Male Camelids

A map showing the distribution of male camelids in the Texas counties surveyed can be seen below in Figure 4.17. Two counties with no male camelids recorded are shown in white. The rest of the surveyed counties are in shades of blue that increase in intensity as the number of camelids increases. When a Global Moran's I spatial correlation was run, an index of -0.03 with a z-score of -0.6 standard deviations. These numbers indicate that the male camelid pattern is random.

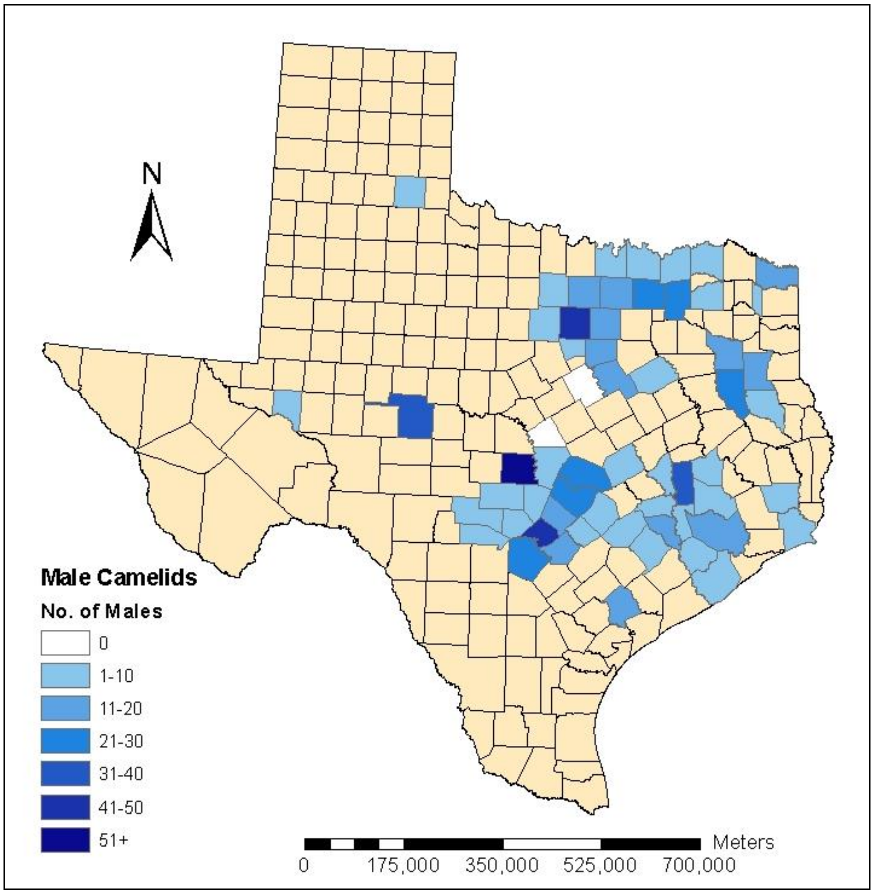

Figure 4.17—Number of male camelids per county.

Figure 4.18 shows the distribution of adult male camelids per farm for each county. The intensity of the blue counties appears to even out in most cases. It appears that most farms have a similar number of adult male camelids.

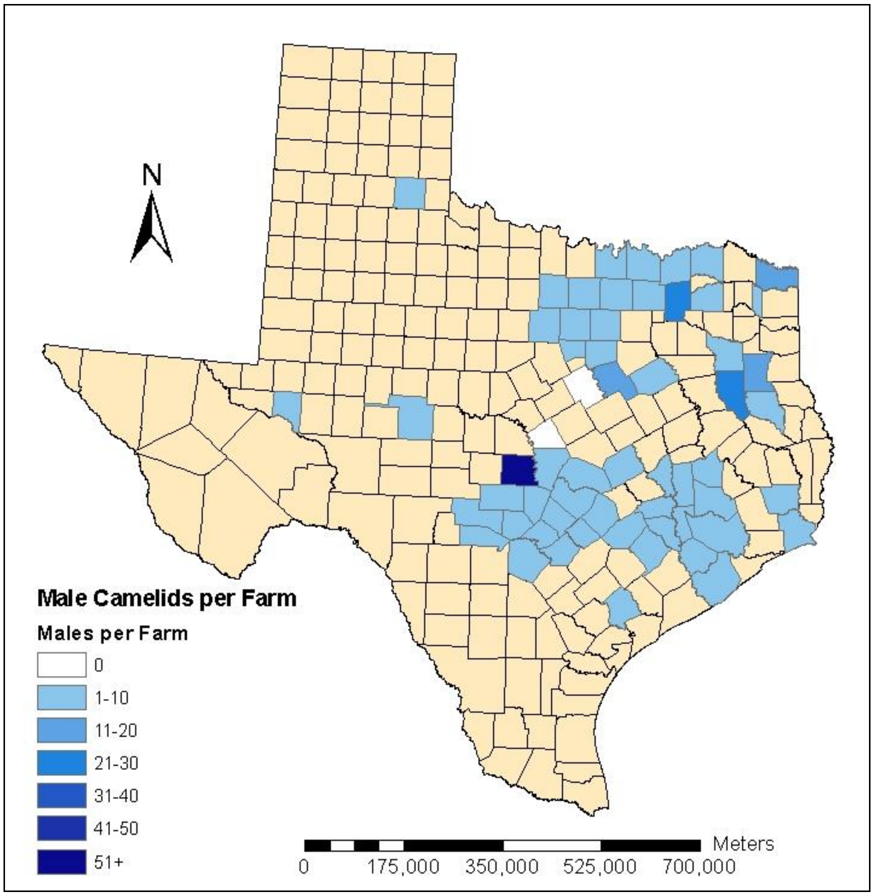

Figure 4.18—Number of male camelids per farm by county.

Hot spot analysis was performed on the male camelids per county, as seen in Figure 4.19. The general G index was equal to zero with one standard deviation. While there may appear to be some clustering, it is not significant and likely due to random chance.

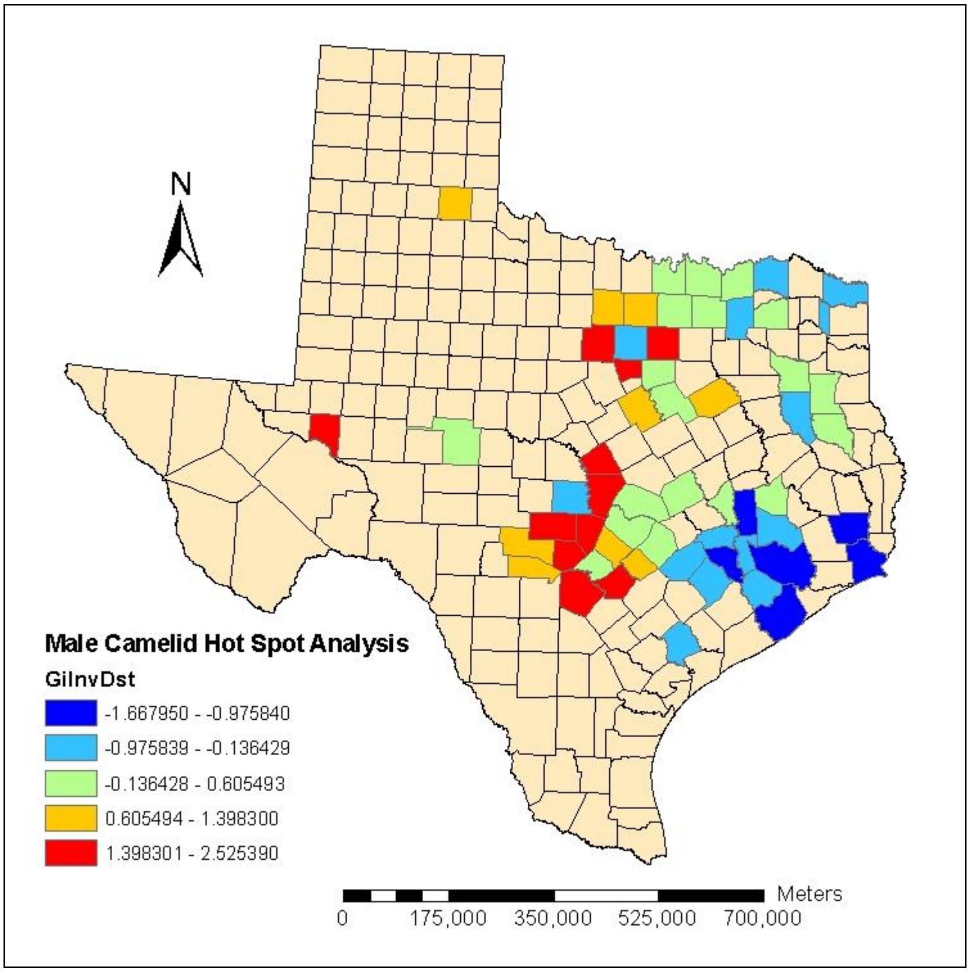

Figure 4.19—Male camelid hotspot analysis.

4.5.5 Adult Female Camelids

A map showing the distribution of female camelids in the Texas counties surveyed can be seen below in Figure 4.20. Five counties with no female camelids recorded are shown in white. The rest of the surveyed counties are in shades of pink that increase in intensity as the number of camelids increases. When a Global Moran's I spatial correlation was run, an index of -0.04 with a z-score of -0.8 standard deviations. These numbers indicate that the female camelid pattern is random.

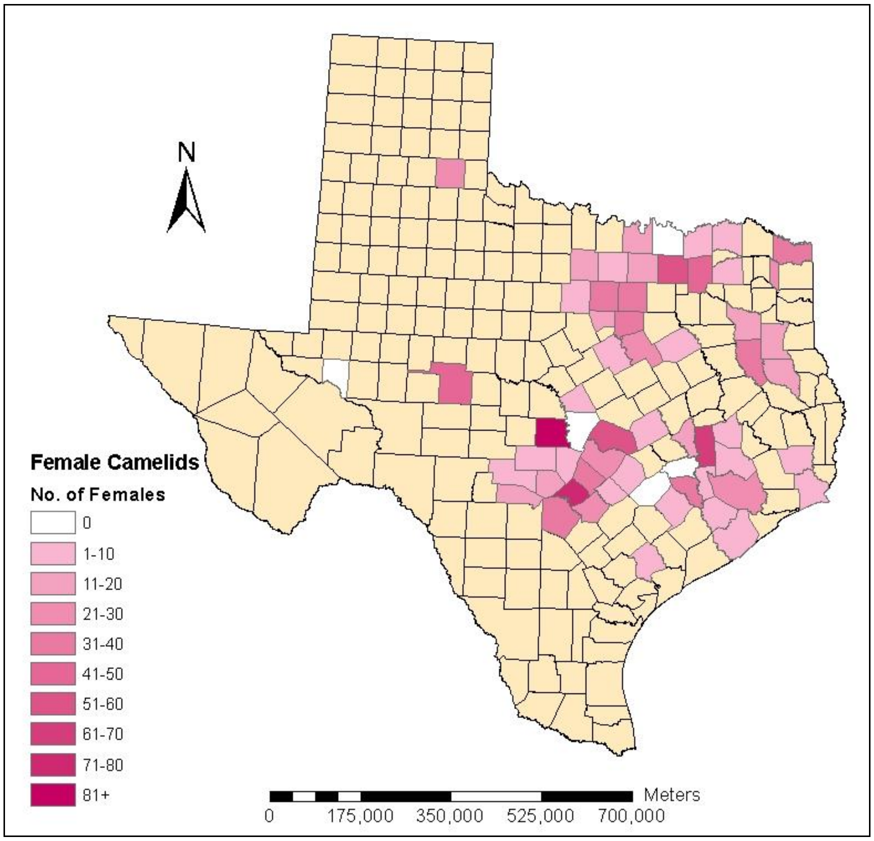

Figure 4.20—Number of female camelids per county.

Figure 4.21 shows the distribution of adult female camelids per farm for each county. The intensity of the pink counties appears to even out in most cases. It appears that most farms have a similar number of adult female camelids.

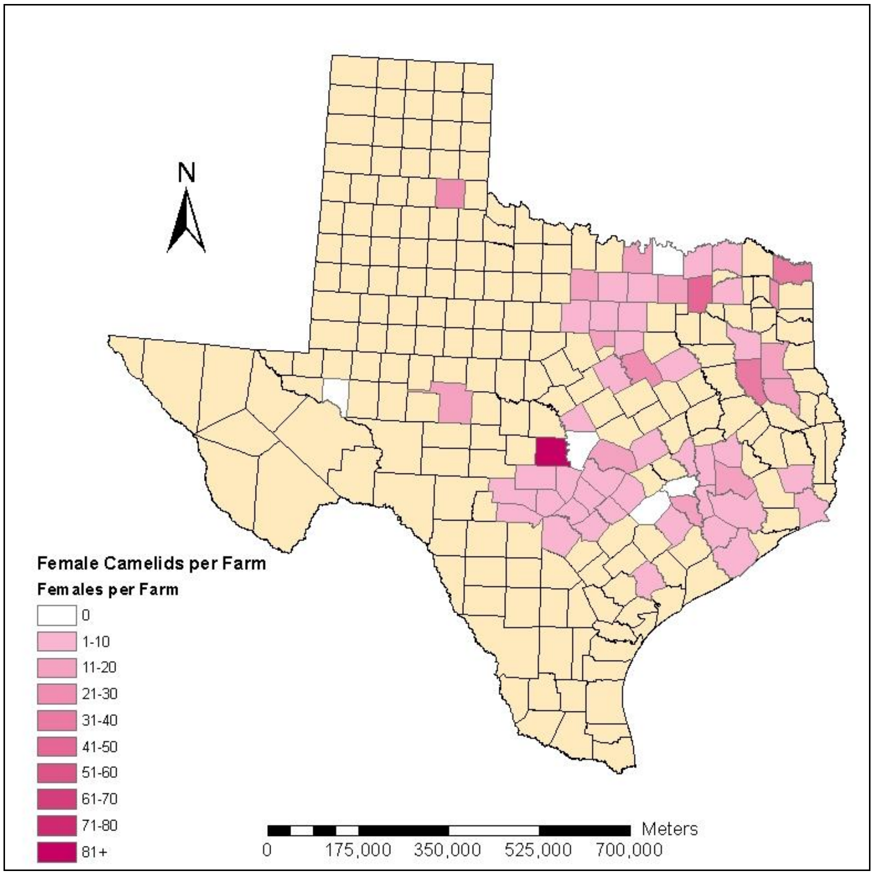

Figure 4.21—Number of female camelids per farm by county.

Hot spot analysis was performed on the female camelids per county, as seen in Figure 4.22. The general G index was equal to zero with 0.5 standard deviations. There is no apparent clustering and number of female camelids per county appears to be random.

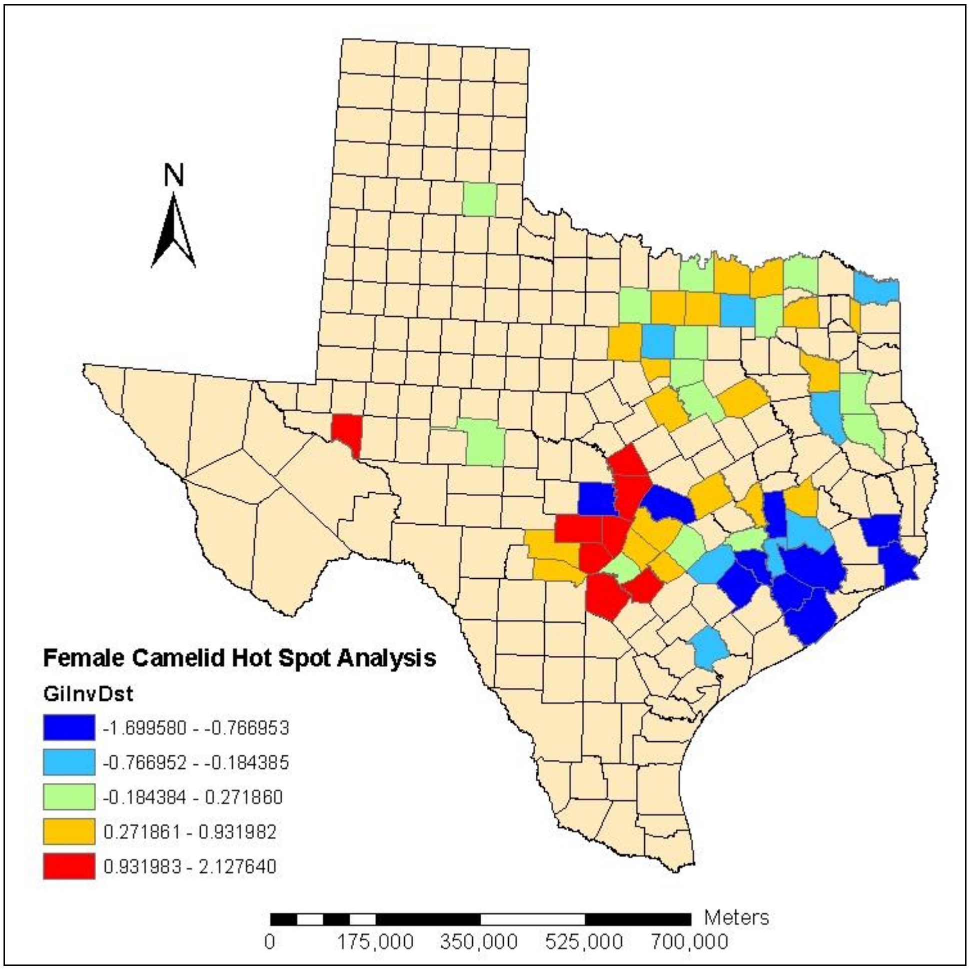

Figure 4.22—Female camelid hotspot analysis.

4.5.6 Crias (< 9 mos.)

A map showing the distribution of camelid crias in the Texas counties surveyed can be seen below in Figure 4.23. Fourteen counties with no crias recorded are shown in white. The rest of the surveyed counties are in shades of green that increase in intensity as the number of camelids increases. When a Global Moran's I spatial correlation was run, an index of -0.03 with a z-score of -0.6 standard deviations. These numbers indicate that the crias pattern is random.

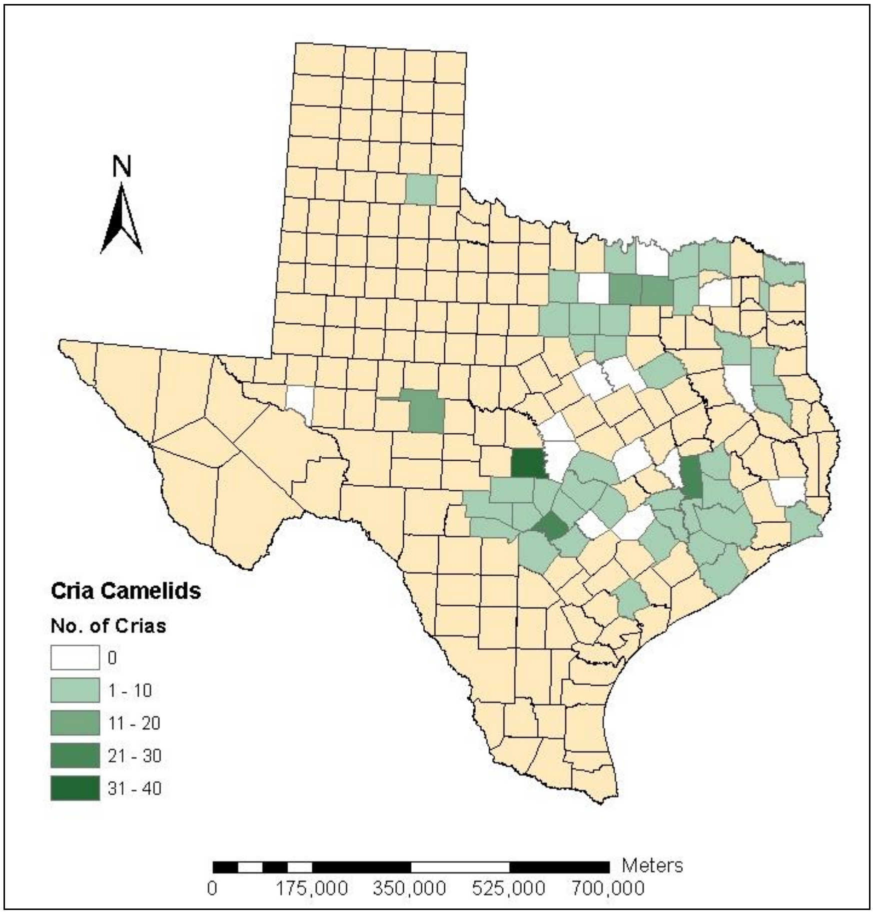

Figure 4.23—Number of crias per county.

Figure 4.24 shows the distribution of crias per farm for each county. The intensity of the green counties appears to even out in most cases. It appears that most farms have a similar number of crias.

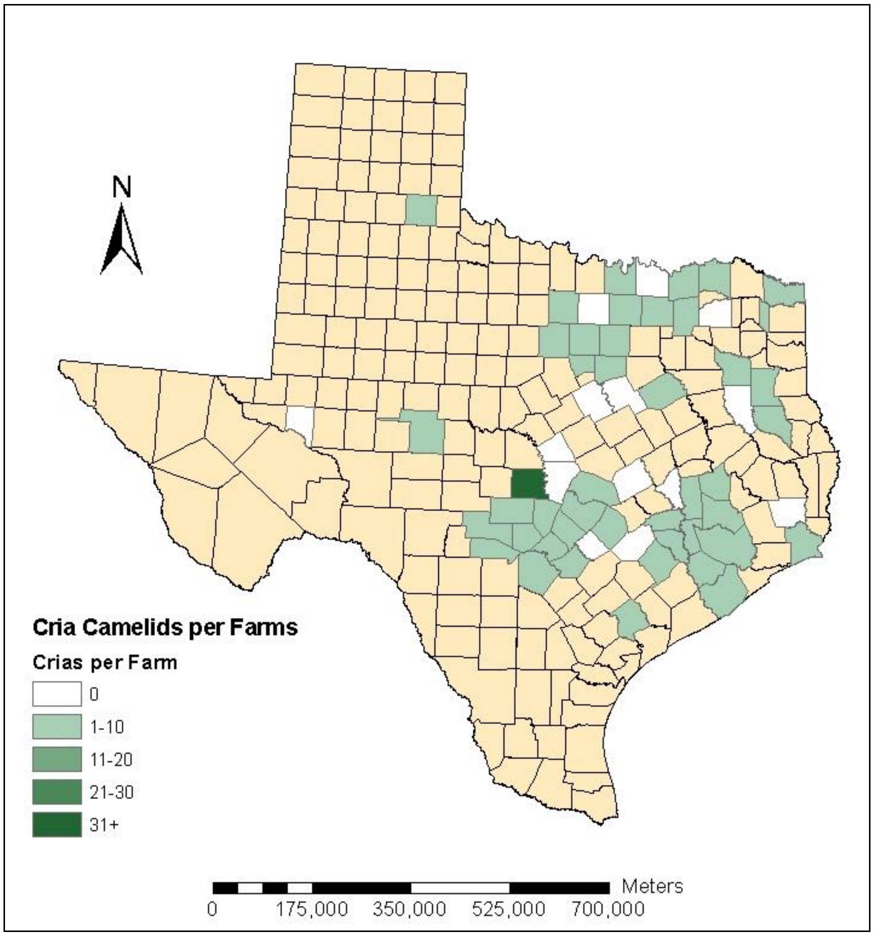

Figure 4.24—Number of crias per farm by county.

Hot spot analysis was performed on the crias per county, as seen in Figure 4.25. The general G index was equal to zero with 0.3 standard deviations. There is no apparent clustering and number of crias per county appears to be random.

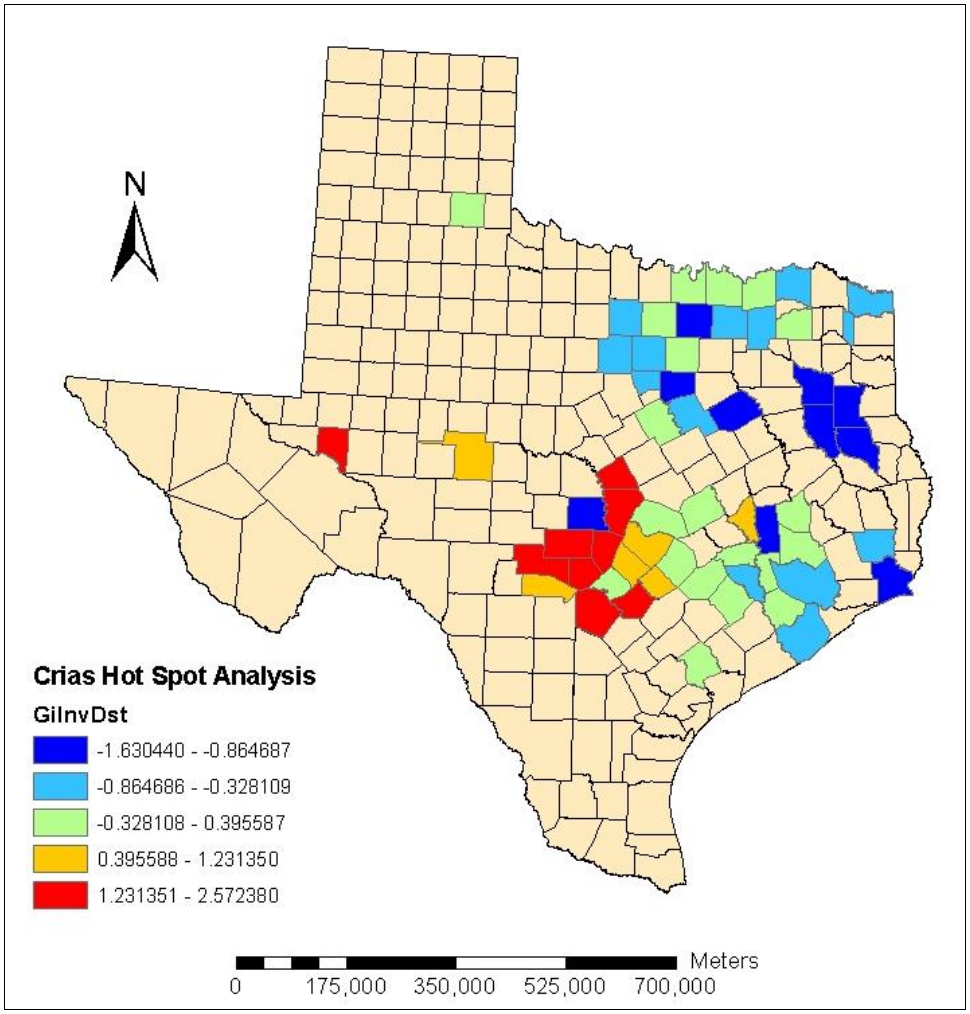

Figure 4.25—Cria hotspot analysis.

4.5.7 Diseases and Disorders of Interest

Cases of Heat Stress. Heat stress cases per farm can be seen below in Figure 4.26. Only about half of the surveyed counties reported cases of heat stress in their camelids. The majority of these counties reported only seeing between one and three cases on their farms.

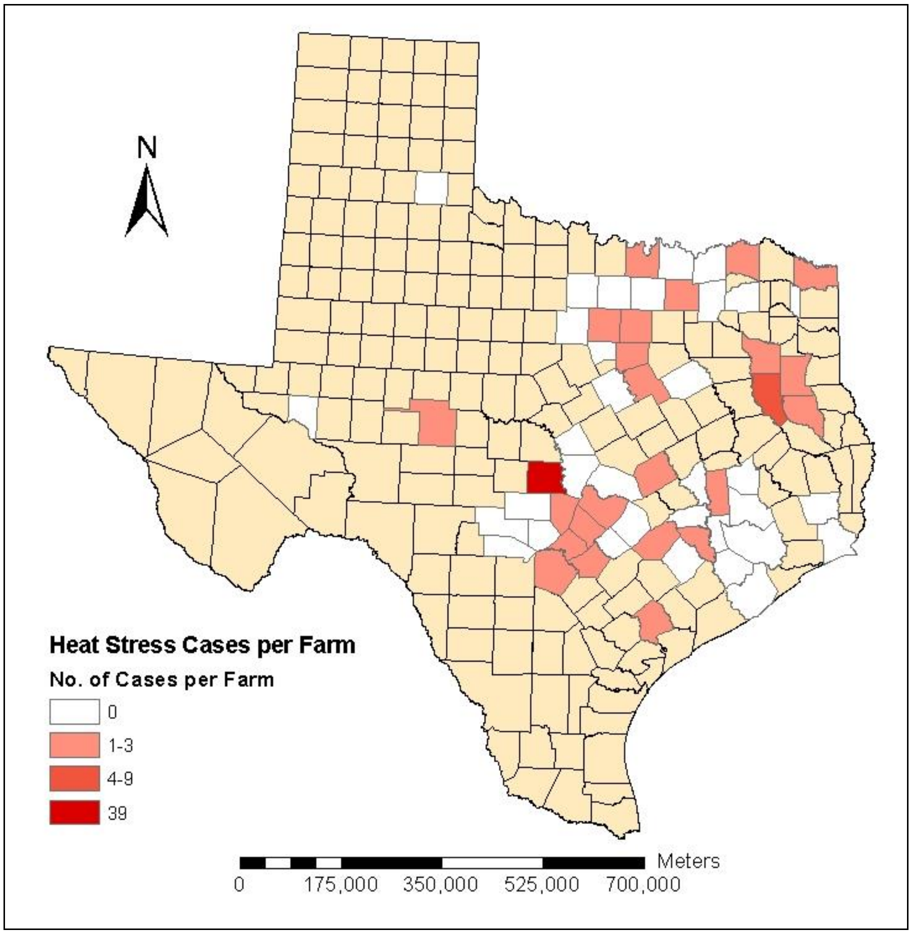

Figure 4.26—Heat stress cases per farm by county.

Hot spot analysis was performed on the heat stress cases per county, as seen in Figure 4.27. The general G index was equal to zero with 0.6 standard deviations. There is no apparent clustering and number of heat stress cases per county appears to be random.

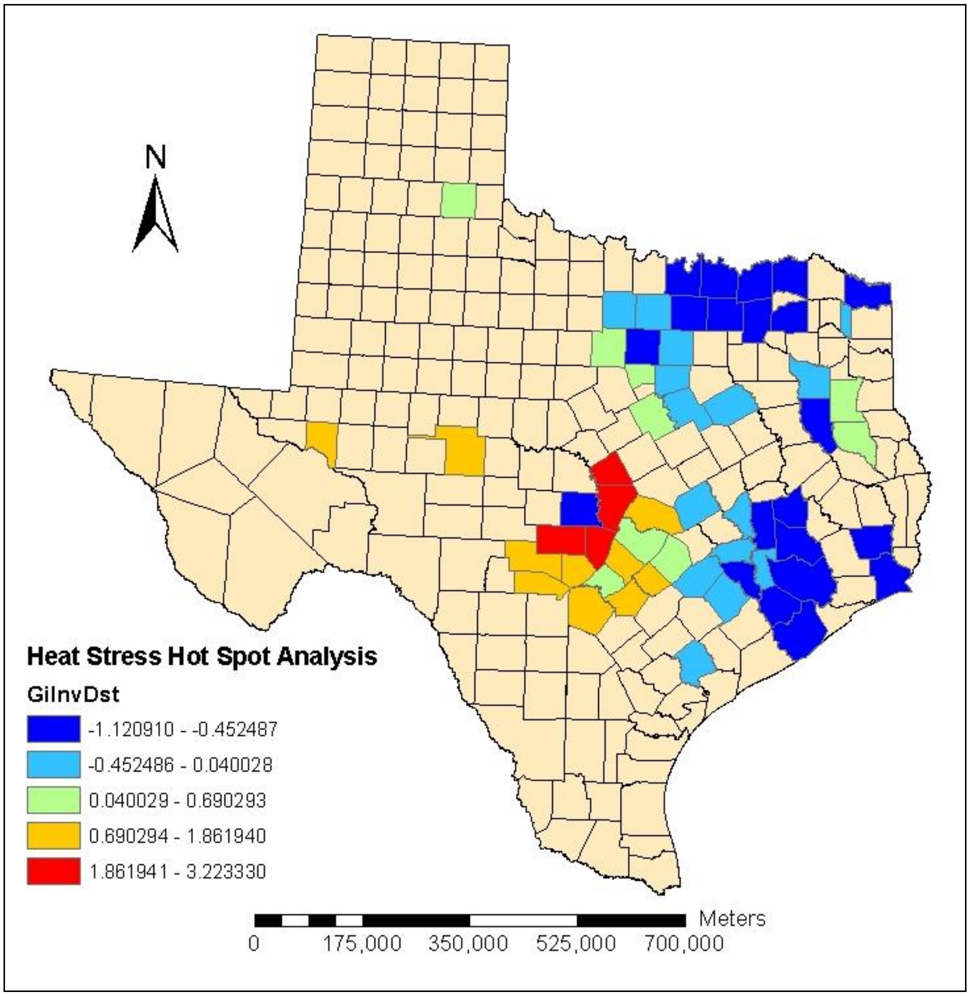

Figure 4.27—Heat stress hotspot analysis.

When a Global Moran's I spatial correlation was run on heat stress cases per county, an index of -0.03 with a z-score of -0.3 standard deviations. These numbers indicate that the heat stress cases pattern is random.

Cases of Intestinal Parasites. Intestinal parasite cases per farm can be seen below in Figure 4.28. Only about half of the surveyed counties reported cases of intestinal parasites in their camelids.

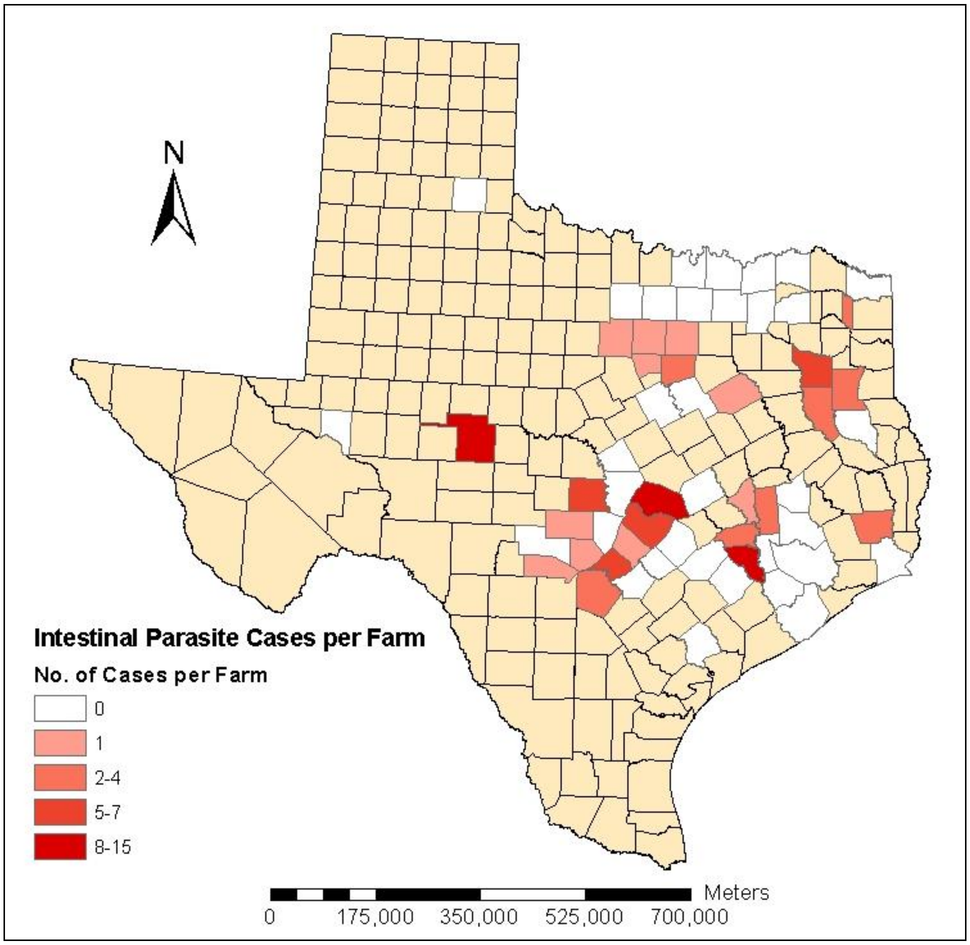

Figure 4.28—Intestinal parasite cases per farm by county.

Hot spot analysis was performed on the intestinal parasite cases per county, as seen in Figure 4.29. The general G index was equal to zero with 0.4 standard deviations. There is no apparent clustering and number of intestinal parasite cases per county appears to be random.

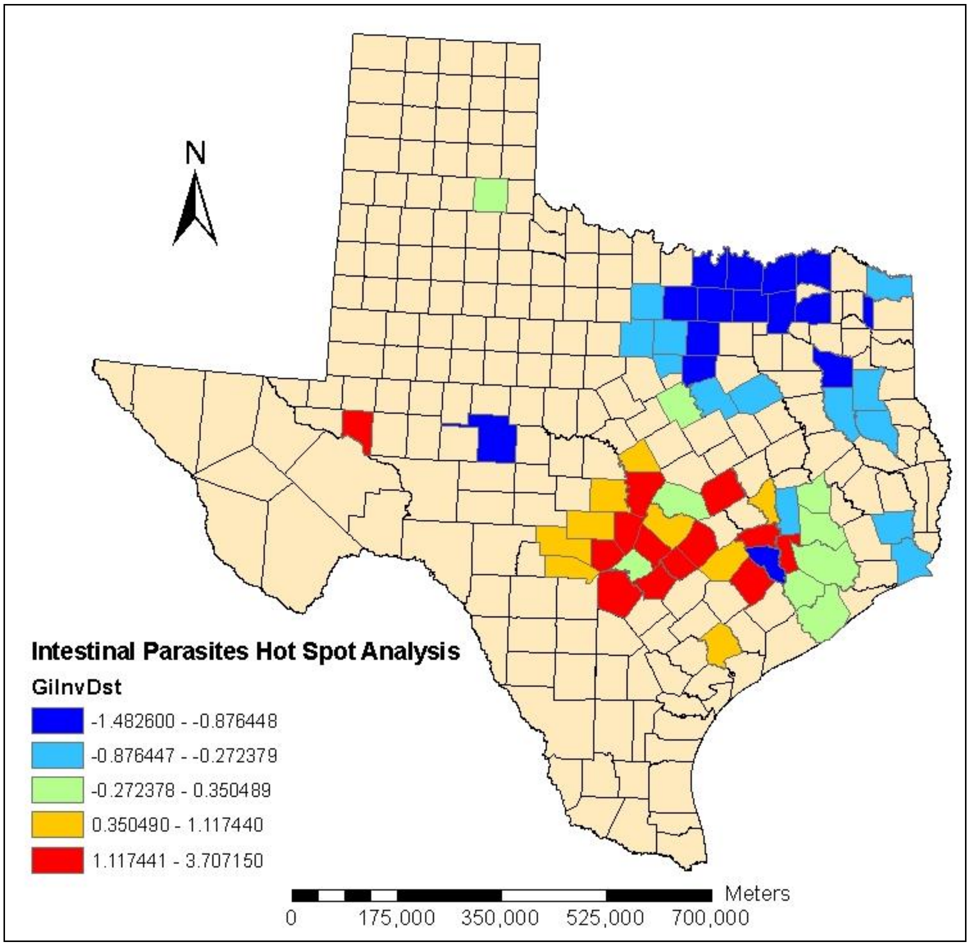

Figure 4.29—Intestinal parasites hotspot analysis.

When a Global Moran's I spatial correlation was run on intestinal parasite cases per county, an index of -0.02 with a z-score of -0.2 standard deviations. These numbers indicate that the intestinal parasite cases pattern is random.

Cases of Mites. Mite cases per farm can be seen below in Figure 4.30. Less than half of the surveyed counties reported cases of intestinal parasites in their camelids. The majority of these farms only saw between one and three cases.

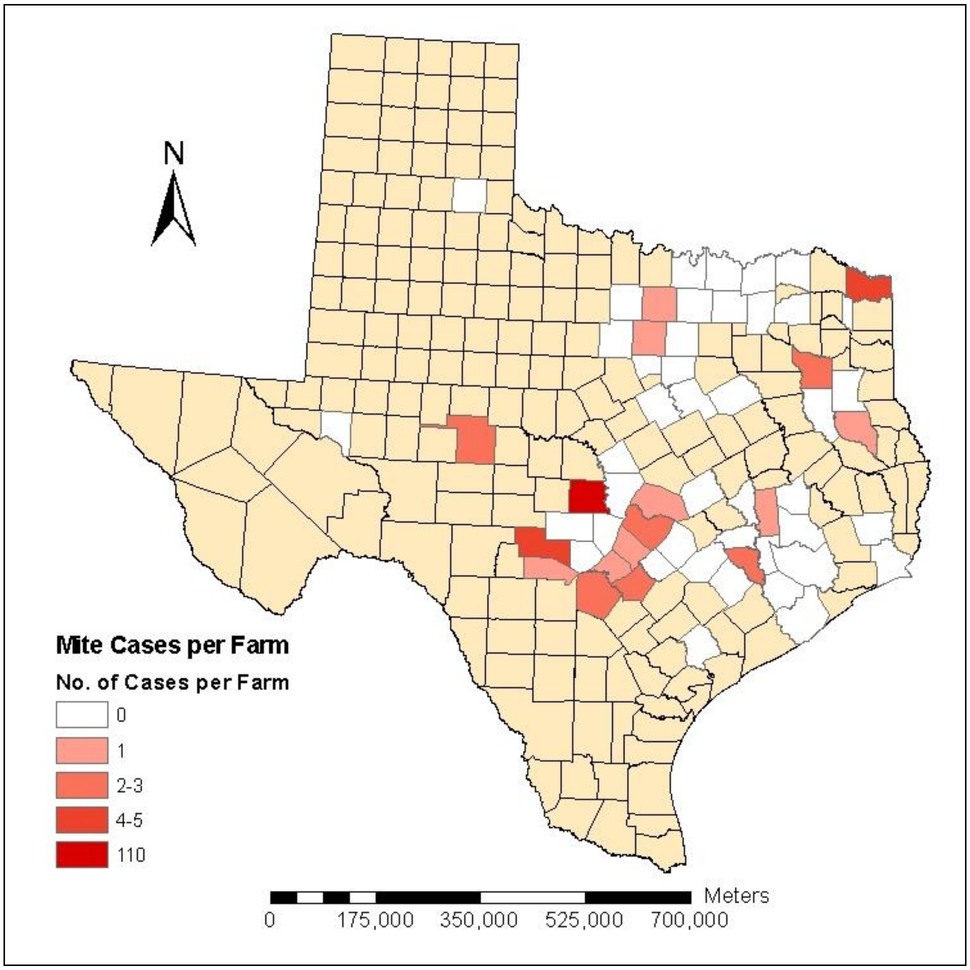

Figure 4.30—Mite cases per farm by county.

Hot spot analysis was performed on the mite cases per county, as seen in Figure 4.31. The general G index was equal to zero with one standard deviation. There is appears to be some clustering however, this is mostly likely due to random chance.

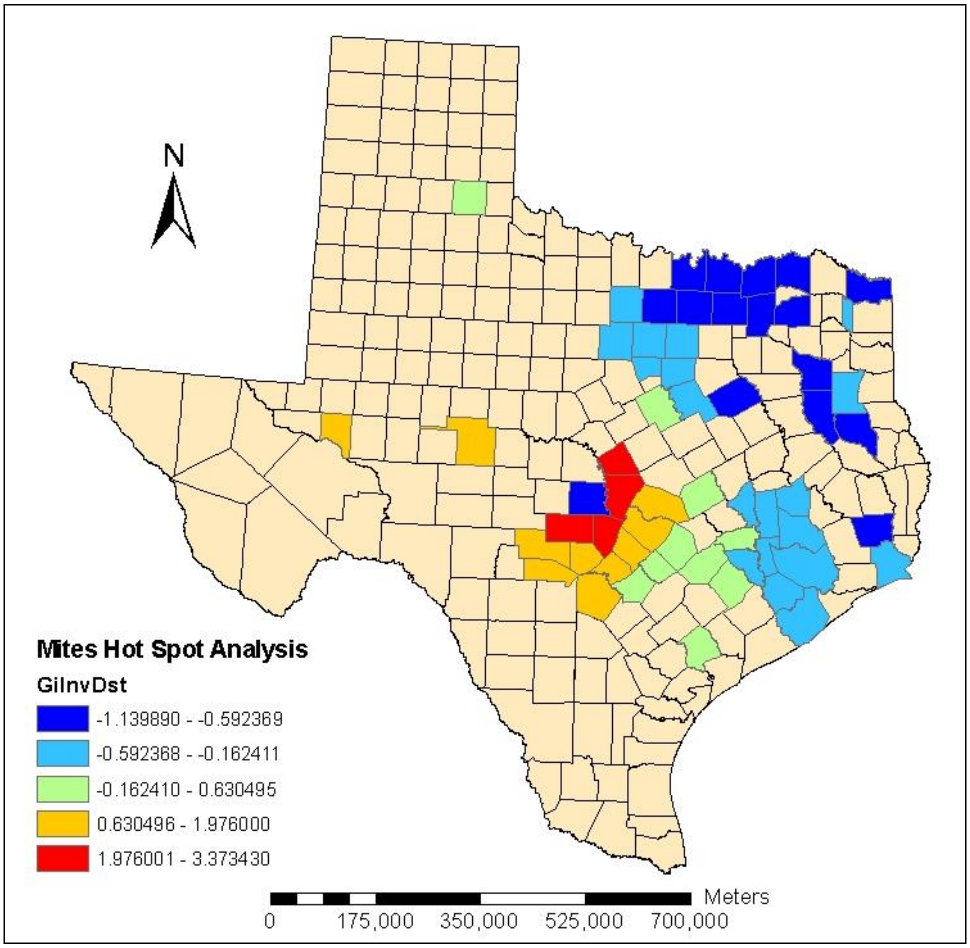

Figure 4.31—Mites hotspot analysis.

When a Global Moran's I spatial correlation was run on mite cases per county, an index of -0.02 with a z-score of -0.2 standard deviations. These numbers indicate that the mite cases pattern is random.

V. DISCUSSION

5.1 Response Rates

5.1.1 Findings

The overall response rate for this study was 55% and is considered moderate. Out of the 320 possible respondents, there were 227 valid potential respondents. Of these 227, we received 125 completed survey responses.

5.1.2 What This Means

More respondents were expected for a variety of reasons. One reason was the increase in internet usage among the general population over the last 10 years. Another is that the possible respondents are or at one time were active with an organization with its own working website. The two organizations, TxOLAN and SCLA were used because they were two of the largest camelid organizations with Texas based members. These groups provide members with information about raising camelids and information about potential camelid health problems. The organizations likely represent Texas domestic camelid owners who are interested in furthering their knowledge and increasing the health and productivity of their herd. These two organizations also seemed eager to participate and were willing to share current and old membership lists.

In general, many of the owners also seemed highly interested in how to increase the quality and production of their llamas and alpacas. Some owners sent emails expressing interest in the research and were grateful to participate in the survey. Many of the owners also had personal websites explaining their llama and/or alpaca farms and hobbies. Considering the amount of personal information about their farms on various websites, more participation was expected.

5.1.3 Problems and Challenges

Problems with sending email reminders likely included: emails going to junk mail, unused email accounts, people traveling out of town and not receiving emails in time. Although a paper copy of the survey was an option, some people may have been deterred after unsuccessfully attempting to access the web survey.

Some participants sent emails complaining that half way through the survey, the website would malfunction. This may have been due to the quality of their computer or the amount of traffic on the website at the time. While the participants were told that their answered questions were automatically saved on the website and that they could sign-in again, some may have chosen not to complete the survey. This may have attributed to the increased amount of missing data in the last part of the survey.

5.2 Descriptive Statistics

5.2.1 Findings

Camelids from 59 Texas counties were included in this study. The three counties with the most farms were Comal, Grimes, and Hays. There was a total of 2,079 camelids included with 54% adult females, 33% adult males, and 14% crias. Camelid owners on average had their camelid farm for six years. The majority of these owners kept their animals as pet companions, participated in competitions, and/or used them for wool production.

Ninety percent of camelid owners reported vaccinating their llamas and alpacas. The majority of these owners give the vaccinations themselves. The majority of camelid owners use insect control, dewormers, and test for parasites.

Seventy-eight percent of owners breed their camelids. Appointment breeding is the most popular breeding strategy. Forty percent of the females owned and 23% of the males owned were bred.

The most prevalent adult camelid diseases and disorders were mites, incisor overgrowth, otitis, intestinal parasites, and heat stress. Prevalent cria diseases and disorders included mites, otitis, intestinal parasites, premature birth, weakness, and poor suckling reflex.

5.2.2 What This Means

The 2002 Census of Agriculture recorded 1,539 llama farms containing a total of 9,518 llamas in Texas. For this study, there were only 125 farms participating with a total of 2,079 llamas and alpacas included. Therefore if the number of farms were to have remained constant for the past 4 years, only approximately 8% of the total number of farms in Texas participated in our survey. If we took 8% of the total llamas recorded in 2002, then we would expect to have 761 llamas included in our survey. However, we have more than two and a half times that number of llamas included in our study. This gives a good indication that the number of llamas and alpacas within Texas have continued to increase over recent years.

When comparing results to the 2002 Census of Agriculture, it should be noted that Comal and Hays counties had a large number of llama farms in 2002, as well as in our study. However, Grimes County in 2002 was listed with only 1 farm, and our study showed there were at least eight farms. This also supports the notion that camelid farms have increased in the past few years.

The ratio of adult females to males is not surprising since herds usually contain more females and males are usually only introduced for breeding. The results showing owners having farms for an average of six years is an indication that llama and alpaca farming in Texas is still fairly new. This information about why owners keep llamas and alpacas (mostly companion animals and/or participate in competitions) supports the assumption that most llama and alpaca owners in Texas are hobby farmers.

The majority of the owners vaccinated their animals and administered the vaccinations themselves. This may have both good and bad implications. It may be considered good that the owners had enough initiative to vaccinate their animals even without having a veterinarian present. However, this could be bad, because their animals may not be receiving the appropriate vaccines or amounts, their animals may be under- or over-vaccinated, the vaccines may not be stored properly, and their animals may be missing out on important physical exams that a veterinarian may be able to provide. The majority of owners use insect control, dewormers, and test for parasites, showing there is a good indication that owners are aware of possible parasitic diseases and are attempting to prevent them. On the other hand, many owners may be having parasitic problems and are trying to regain control of the diseases.

Most owners chose to use appointment breeding with their llamas and alpacas. This implies that the majority of camelid owners are being careful not to over-breed their herds and are possibly trying to prevent inbreeding. Another reason may be that they are trying to breed for the best wool production or show animals.

The most prevalent adult and cria camelid diseases and disorders were mites (mostly *Sarcoptes*), incisor overgrowth, otitis, intestinal parasites, heat stress, poor suckling reflex, weakness, and premature birth. Some of these problems are fairly preventable, such as mites, intestinal parasites, and heat stress. Actions that can be taken will be discussed in a following section.

5.2.1 Problems and Challenges

Possible selection bias may have occurred because the sampling frame was incomplete due to this being a convenience sample and not all Texas llama or alpaca owners were included. There most likely were some llama farms not listed in either of the associations. Misclassification bias was also a possibility. If a cria was born with a minor heart disorder, for example, then it may have gone undetected until adulthood or it may never have been detected. There was also the possibility that some crias may have died after birth and were disposed of without a necropsy to determine cause of death.

The validity of the disease information could have caused problems. If an owner was diagnosing his/her sick animals, then they may have determined a severe disease was something minor or visa-versa. For the majority of the important diseases of interest, a second question was asked about who diagnosed the animal. If a diagnostic laboratory or veterinarian diagnosed the disease it was safer to assume the diagnosis was correct. The survey did not ask whether a friend or colleague made the diagnosis and this may have had an affect on the accuracy. Another point that may have an affect on the owner's accuracy of diagnosis was their agricultural background. An owner with a strong background in agriculture may be more familiar the symptoms of certain diseases and disorders. Diseases that had a lot of owners diagnosing included: mites, skin allergies, zinc-responsive allergies, otitis, *E. coli*, intestinal parasites, liver flukes, and mastitis. Non-response bias may have occurred because some individuals may not have been comfortable answering an online survey or some individuals may have no longer owned llamas or alpacas.

Confounding is always present and never completely avoidable. Any factor associated with the exposure and outcome, but not directly a step between the two is considered a confounder. There may be environmental factors that had an affect on a disease's outcome. Temperature or weather conditions could have caused problems, along with the quality of the feed or pasture the animal consumed. During certain temperature extremes or weather conditions, such disorders like heat stress would be more likely to occur during the hottest time of the year. Not all the camelid farms would experience the same set of climate and weather extremes across the state.

5.3 Univariate Analysis

5.3.1 Findings

There were eight outcome variables used in the univariate analysis. These variables were zinc-responsive skin disease, chronic watery eyes, skin allergies, mites, intestinal parasites, heat stress, colic, and incisor overgrowth. Thirty-nine independent variables were used to check for associations.

Zinc-responsive skin disease was associated with testing for parasites, appointment-only breeding, deworming reason, number of years owned, breeding camelids, and maximum distance traveled.

Chronic watery eyes was associated with the source of feed, deworming reason, dewormer type, domestic animal contact, fencing type, insect control type, where vaccines were obtained, vaccination type, vitamin supplements, wildlife contact, travel, and how often toenails were trimmed. Chronic watery eyes was more likely to occur in animals vaccinated with other types of vaccines besides clostridium/CDT. These other vaccines or injections may have included BO-SE Selenium/Vitamin E, vitamin A&D, tetanus toxoid, leptospirosis, and rabies.

Skin allergies was associated with the source of hay and alfalfa, breeding system type, deworming reason, dewormer type, domestic animal contact, who gives the vaccination, pasture supplements, number of shearing per year, access to feed storage, vaccination type, wildlife contact, number of years owned, and number of acres. When looking at the direction of associations, camelids were more likely to have skin allergies if their food was from non-retail sources. These sources may have included bulk delivery, home grown and other sources. Llamas and alpacas were also more likely to have skin allergies when the reason for deworming the herd was as a general preventative as well as for other reasons. These other reasons may have included fecal tests indicated a need, the presence of a parasite-related illness, or worms were seen. When animals were sheared two or more times per year they were more likely to have skin allergies. Possibly the shearing was an attempt to deter skin allergies, or it may have made the animals more likely to be exposed to skin irritants. Camelids were also more likely to have problems with skin allergies when they had contact with raccoons, opossums, and other wildlife. Owners, who had camelids for 7 or more years, were more likely to have animals with skin allergies. Perhaps, over time owners were more likely to notice skin problems or they may simply have older animals that have developed allergies as they have aged.

Mites were associated with breeding system type, use of dewormer, deworming reason, dewormer type, insect control, insect control type, non-domestic animal contact, where vaccines obtained, type of camelid, parasite testing, parasite test type, pasture supplements, shearings per year, vaccination type, travel, and number of years owned. Camelids that did not participate in appointment breeding were less likely to have mites. Other types of breeding included field breeding and pen breeding. Contact with non-domesticated animals also was more likely to occur in camelids that had mites. Alpaca herds were more likely to have mite problems than llama only and mixed herds. Llamas and alpacas were also more likely to have mites if they were routinely tested for parasites. This may be due to owners or veterinarians spending more time examining animals for health problems. It is also interesting to note that animals sheared 2 or more times per year were less likely to have problems with mites.

Intestinal parasites were associated with owner activity, breeding, breeding system, deworming reason, dewormer type, owner information, parasite testing, parasite test type, pasture supplements, primary shelter, fighting teeth removed, travel reason, vitamin supplement, and travel. Intestinal parasites were more likely to occur in camelids that participated in multiple owner activities. Camelids were also less likely to have parasites when their owners routinely dewormed as a general preventative.

Overgrowth of incisors was associated with owner activity, source of feed, source of hay/alfalfa, insect control spraying and/or other methods, primary shelter, feed storage access, fighting teeth removed, vitamin supplements, and travel.

Heat stress was associated with owner activity, breeding system, dewormer usage, deworming reason, dewormer type, owner information, insect control, insect control type, separation of males, parasite testing, pasture supplements, fighting teeth removed, vaccinated, vaccine type, vitamin supplements, wildlife contact, and travel. Participating in multiple activities including wool production and shows was more likely to occur with animals that suffered heat stress. Animals vaccinated with clostridium/CDT and other vaccinations were more likely to suffer from heat stress than animals not vaccinated.

Colic was associated with owner activity, breeding system, dewormer usage, deworming reason, dewormer type, insect control, type of camelids, parasite testing, parasite test type, primary shelter, fighting teeth removed, travel reason, vaccinated, vaccine type, vitamin supplements, water source, wildlife contact, travel, number of years owned, acreage, and toenail trimmings per year. Camelids participating in wool production or shows along with other activities were more likely to suffer from colic. Perhaps being involved in many activities led to stress that affected digestion. Also, animals may simply have had their eating and drinking habits disrupted enough to develop conditions leading to colic. Colic was also more likely in animals that were tested for parasites. In these cases, the animals may have been infected with parasites which led to colic. Camelids that only had access to a water trough were more likely to colic than animals with access to other sources of water. Traveling 5 or more times per year made camelids more likely to colic, most likely due to the increase in stress. Owners that have raised camelids for 7 or more years were more likely to see colic in their herd.

5.3.2 What This Means

Many of the associated independent variables were seen repeatedly in each disease or disorder. Variables involving parasites, insects, and/or dewormers were included in each of the univariate results. This makes sense that these subjects would have a relationship with many of these diseases. The usage of dewormers and preventive controls would either decrease the probability of disease if used on an uninfected farm, or their usage would be increased on farms where animals were already infected.

How many years the owners have had camelids makes the most sense out of the variables associated with zinc-responsive skin disease. The longer an owner has had camelids, the more likely they would see a particular disease.

Contact with domestic animals or wildlife may be associated with chronic watery eyes because of an allergy the camelid has. Also, if there are many other domestic animals around, they could be stirring up dust or pollen causing the watery eye problem.

Many of the variables associated with skin allergies could make logical sense. Lots of contact with domestic animals or wildlife could have an effect on the flea population or other insects in the area that might irritate the skin or cause allergic reactions. Vaccination or dewormers may also cause allergic reactions when used on particular animals. The number of shearings per year could increase allergies when the skin is left exposed, or it may decrease the allergies when the pollens trapped in the wool are shorn.

The insect control variables and number of shearings per year make sense to be associated with mites. Either there may be an increase in insect control when mites are seen, or there is insufficient insect control which leads to a mite problem. The number of shearings per year could increase mite problems when the skin is left exposed, or it may decrease the mite problem when the wool is shorn, exposing the mites.

It makes sense that the deworming and parasites variables were associated with intestinal parasites. If a farm is infected with intestinal parasites then you would expect to see an increase in parasite testing and dewormer usage. If a farm is free of intestinal parasites then you would expect to see preventive measures being taken, such as, occasional deworming or testing.

Overgrowth of incisors and vitamin supplements make the most sense when looking at the associations. Changes in diet or supplementations can have an effect on tooth growth. Or if incisors are overgrown then the owner may be changing supplements to slow future growth.

Heat stress associations make a lot of sense when looking at travel and owner activity. Camelids that are being moved around a lot may already be under additional stress, causing them to not drink enough water. These animals may also be in poorly ventilated trailers, traveling into warmer climates.

Colic's associations with travel, vitamin supplements, water source, and number of years owners have had camelids are the most plausible. Travel causes stress in animals, making them more susceptible to colic. Vitamin supplements may be added in an attempt to prevent colic in the animals. If a particular water source is not adequate, then an animal may not be drinking enough to easily digest its food. The more years an owner has camelids, then the more likely they will learn how to prevent colic. On the other hand, the longer an owner has these animals, the more likely they will have animal with colic.

5.3.3 Problems and Challenges

The biggest problem encountered while attempting the modeling was the insufficient sample size and the large number of independent variables. When zeros were found during the univariate analysis, the independent variables would be re-categorized. Some of these independent variables were re-categorized multiple times, probably causing a loss of biological sense, and definitely a loss of details. In future surveys it may be beneficial to automatically combine adult male and female camelids in the survey due to management similarities, but still keep crias separate.

5.4 Multivariable Analysis

5.4.1 Findings

The five dependent variables with multivariable models were skin allergies, mites, intestinal parasites, heat stress, and colic. The variable significant in the skin allergies model was the number of shearings per year. The variables significant in the mites' model were parasite testing and non-domestic animal contact. The intestinal parasite model included deworming reasons and reason for travel. The variable retained in the model for heat stress was owner activity. The variables significant in the model for colic were parasite testing and number of years owners have had camelids.

5.4.2 What This Means

Animals on farms where shearings occur twice or more per year were 4-times more likely to suffer from skin allergies than animals sheared only once per year. Or in the reverse, animals that suffered from skin allergies were sheared more often.

Farms with mite infections were 7-times more likely to test for parasites than farms without mites. Also, farms with mites were 20-times more likely to have non-domestic animals come in contact with their camelids. Another possibility is when the camelids were tested for parasites; they were more likely to discover mite infestations. Perhaps, owners that test for parasites are more likely to look closely at their animals and examine their skin for mites.

Farms where animals are not dewormed are 1.4-times more likely to have animals with intestinal parasites than farms that deworm as a general preventative. Farms where animals are dewormed for reasons other than general preventative are 4.1-

times more likely to have intestinal parasites than farms that do not deworm. In addition, farms where animals are dewormed as a general preventative and for other reasons are 5.7-times more likely to have intestinal parasites than farms that do not deworm. Animals on farms that use a dewormer as a general preventative are less likely to have intestinal parasites. While animals that use a dewormer for other reasons are more likely to have parasites.

Farms with animals that travel to shows only are 2.1-times more likely to have intestinal parasites than farms that do not have animals that travel. Farms with animals that travel to shows and for other reasons are 3.4-times more likely to have intestinal parasites. Farms where animals do not travel at all are 3-times more likely to have intestinal parasites than farms where animals travel for reasons other than shows. When the reasons for travel included shows and/or competitions then the farms were more likely to be infected with intestinal parasites. Animals participating in these shows may be in close contact with contaminated feces or food of infected animals, making the parasites easily transmissible.

Owner activity and heat stress were found to be significantly associated. Camelid farms where owners participated in wool/shows and other activities were 5.9-times (1/0.2) more likely to have animals suffer from heat stress than farms where owners only participated in wool/shows. In addition, camelid farms where owners participated in wool/shows and other activities were 3.8-times more likely to have animals suffer from heat stress than farms where owners only participated in other activities. If the animals were not likely to suffer from heat stress then the owner may be more active with their camelids. On the other hand, animals suffering from heat stress might be too overworked or under too much stress from the owner activities.

Camelid farms that test for parasites are 4.6-times more likely to have problems with colic than farms that do not test for parasites. Colic may be occurring in animals suffering from intestinal parasites, because their gastrointestinal system is already damaged or not functioning properly. Therefore, animals that are not treated for parasites may be more likely to colic. Owners who have kept camelids for 4-6 years are 4.8-times more likely to have animals suffer from colic than owners that have only had animals 1-3 years. Owners who have kept camelids for 7-12 years are 9.5-times more likely to have animals suffer from colic than owners that have only had animals 1-3 years. Owners who have kept camelids for 13+ years are 8.1-times more likely to have animals suffer from colic than owners that have only had animals 1-3 years. The longer an owner keeps camelids, then the more likely he will run into conditions that cause an animal to colic. Also, an owner with lots of experience dealing with colic may be more likely to prevent his/her animals from colicing.

5.4.3 Problems and Challenges

Many of the possible independent variables were subsets of other variables; therefore care had to be taken to not use variables from the same subset in the model. When this occurred, problems with collinearity arose.

Insufficient sample size was a major problem in the multivariable analysis. When attempting to create and insert interaction terms into the model, the interaction terms would not be processed while running the model. This may have been a result of collinearity or an insufficient amount of data.

Another problem with the study is that causation and incidence cannot be determined. A cross-sectional study does not follow the animals over time to determine if the disease came before or after the associated independent variables. This makes interpretation of associations difficult to explain, as there is often more than one possible answer.

5.5 Spatial Analysis

5.5.1 Findings

The majority of included camelid farms are located in central and eastern Texas counties. Most counties contain predominantly female herds. The majority of tests to determine farm clustering showed there was no significant evidence of clustering. No significant evidence of clustering by males, females, or crias was found. Cases of heat stress, intestinal parasites, and mites had no significant evidence of clustering by county.

5.5.2 What This Means

There was no significant evidence of clustering found during the spatial analysis, however, that does not mean that there is not clustering present. Due to the small sample size, the data was considerably spread out when divided by the farm's residence county. However, the results for this project show that location does not have a significant association with the outcome of the surveyed diseases.

5.5.3 Problems and Challenges

Visual bias is a possible problem in the spatial analysis. The counties vary in shape and size and this makes comparison difficult. Larger areas tend to dominate even if their values are not significant. There is also the problem of edge effect, when the counties on the border are made somewhat unimportant because out-of-state counties surrounding them are ignored.

Selection bias is present because there is a definite lack of reporting as can be seen in the counties that had no information available on the number of llamas or llama farms. This incomplete sampling frame will certainly have an affect on the spatial analysis.

5.6 Recommendations

5.6.1 Veterinarians

This survey reported that seventy-four percent of camelid owners obtained health information from their veterinarian. It is important for veterinarians to stay up-to-date on camelid health findings, especially as these camelid farms continue to emerge and grow. With approximately half of the camelids coming into contact with other domesticated animals and/or wildlife, veterinarians need to make owners aware of possible disease transmissions. They should discuss symptoms of common diseases and health disorders with owners.

Veterinarians should also discuss appropriate vaccination schedules with their clients, as the majority of owners vaccinate their own animals and there is room for improvement. Veterinarians should discuss the major preventable diseases with camelid owners. Mites and intestinal parasites can be prevented by using effective insect control and dewormers.

5.6.2 Camelid Owners

Owners should be aware of the major diseases causing problems in llamas and alpacas within the state of Texas. Infectious diseases, mites, intestinal parasites, and heat stress may be preventable. Owners should make sure their animals are protected from insects and mites by using sprays that are safe for their animals. Dewormers should be used in a timely manner to prevent the spread of parasites and parasitic diseases amongst their herd. Owners who do not currently vaccinate should talk to their veterinarian to discuss what local diseases can be prevented by vaccinating.

Heat stress is preventable. Owners should make sure their animals have sufficient water during the hottest months and plenty of shaded areas. Shearing during the summer months will also allow for the animals to remain cooler. Another option for decreasing the heat stress on breeding females and crias is to breed in the spring in order to have crias born in the cooler winter months. Owners need to be better informed about how to recognize early heat stress and begin treatment.

Owners need to be aware of the specific nutrients included in their camelids' diet. They should send their forage for testing to determine the mineral content, so they can properly supplement. Owners should also be aware that too much calcium in their llama or alpaca's diet will prevent necessary manganese and zinc absorption.

In addition, owners should be aware of their animals' body condition and weight. Fluctuations in body condition and weight may be a sign of disease or nutritional disorder. Crias should also be weighed at birth to determine if they are premature and need veterinary attention.

VI. CONCLUSIONS

The overall result of the survey is that now we have a better idea of what is occurring with the domesticated camelid population in Texas. We know that many llama and alpaca owners are involved in various activities, and we know that most owners appear to be very involved with the care and management of their animals. At the time of this survey, there were not serious disease problems in the sampled population. Most of the diseases or disorders that were prevalent are also presently controllable. This study may be able to help educate interested owners with how to avoid or rid their animals of problems like mites and intestinal parasites.

Even though this study type prevented us from determining disease causation, it shows which management and nutritional factors had an association with the diseases of interest. Future studies can look more closely at these associations and determine causation. While the clustering analysis was inconclusive, some of the maps created from the data helped visualize the descriptive data and the spread of camelids across Texas. This Texas camelid study is a good basis for finding the answers to questions in further research studies.

REFERENCES

1. Fowler ME. Medical management of South American camelids in North America. *Journal of Camel Practice and Research* 1997;4:123-129.

2. 2002 Census of Agriculture. Washington D.C.: National Agriculture Statistics Service, 2004. Available at: http://www.nass.usda.gov/census/census02/volume1/tx/st48_2_022_022.pdf Accessed 2006.

3. Escobar RC. *Animal Breeding and Production of American Camelids*. Lima, Peru: Ron Hennig - Patience, 1984.

4. Evans N, Baum K. Llama Medical Management: International Llama Association Available at: http://www.scla.us/llama_medical_management.html Accessed 2006.

5. Beattie LC, Crisman CE. *Making the Most of Your Llama*. Longview, WA: Kopacetic Ink, 1987.

6. Markham D, Hilton P, Hochsprung D, Schreiner D, Tompkins J, et al. An Alternative for Effective Predator Management: International Llama Association Available at: http://www.scla.us/guard_llamas.html Accessed 2006.

7. Goldsmith B. Llama Housing: International Llama Registry Available at: http://www.scla.us/llama_housing.html Accessed 2006.

8. Taylor P, Taylor S. Llama Herd Management: International Llama Association Available at: http://www.scla.us/herd%20management.html Accessed 2006.

9. Hoffman C, Asmus I. *Caring for Llamas: A Health and Management Guide*. Livermore, CO: Rocky Mountain Lama Association, 1989.

10. Jensen J. Camelid Critical Care. Annual Exotic Pet Conference 2002;43-47.

11. Fowler ME. Unique parasitisms of South American camelids in North and South America. *Journal of Camel Practice and Research* 1997;4:257-260.

12. Campbell JR. Effect of bovine viral diarrhea virus in the feedlot. *Veterinary Clinics of North America-Food Animal Practice* 2004;20:39-50.

13. Evermann JF. Pestiviral infection of llamas and alpacas. *Small Ruminant Research* 2006;61:201-206.

14. Wilkins PA, Del Piero F. West Nile virus: lessons from the 21st century. *Journal of Veterinary Emergency and Critical Care* 2004;14:2-14.

15. Kutzler MA, Baker RJ, Mattson DE. Humoral response to West Nile virus vaccination in alpacas and llamas. *Journal of the American Veterinary Medical Association* 2004;225:414-416.

16. Jensen JM. *Camelid Drug Formulary*. 1st ed. San Antonio: Game Ranch Health, 2006.

17. Jones PH. Bovine paratuberculosis: ongoing challenges, renewed concerns. *In Practice* 2001;23:402-411.

18. Stabel J. Johne's Disease: A Hidden Threat. *Journal of Dairy Science* 1998;81:283-288.

19. Jouany JP. The digestion in camelids; a comparison to ruminants. *Productions Animales* 2000;13:165-176.

20. Van Saun RJ, Smith BB, Watrous BJ. Evaluation of vitamin D status of llamas and alpacas with hypophosphatemic rickets. *Journal of the American Veterinary Medical Association* 1996;209:1128-1133.

21. Van Saun RJ. Nutritional diseases of South American camelids. *Small Ruminant Research* 2006;61:153-164.

22. Van Saun RJ. Nutrient requirements of South American camelids: A factorial approach. *Small Ruminant Research* 2006;61:165-186.

23. Brown BW. A review on reproduction in South American camelids. *Animal Reproduction Science* 2000;58:169-195.

24. Skidmore JA. The main challenges facing camel reproduction research in the 21(st) century. *Reproduction* 2002:37-47.

25. Balter O, Balter K. Demands on web survey tools for epidemiological research. *European Journal of Epidemiology* 2005;20:137-139.

26. Huang HM, Liaw SS. Exploring users' attitudes and intentions toward the web as a survey tool. *Computers in Human Behavior* 2005;21:729-743.

27. Dillman DA, Tortora RD, Bowker D. Principles for Constructing Web Surveys. *The Social and Economic Sciences Research Center Technical Report* 1999.

28. Couper MP, Tourangeau R, Conrad FG, Crawford SD. What they see is what we get - Response options for web surveys. *Social Science Computer Review* 2004;22:111-127.

29. Heerwegh D, Loosveldt G. An evaluation of the effect of response formats on data quality in web surveys. *Social Science Computer Review* 2002;20:471-484.

30. Hayslett MM, Wildemuth BM. Pixels or pencils? The relative effectiveness of Web-based versus paper surveys. *Library & Information Science Research* 2004;26:73-93.

31. Heerwegh D. Effects of personal salutations in e-mail invitations to participate in a web survey. *Public Opinion Quarterly* 2005;69:588-598.

32. Wright KB. Researching Internet-based populations: Advantages and disadvantages of online survey research, online questionnaire authoring software packages, and Web survey services. *Journal of Computer-Mediated Communication* 2005;10.

33. Fricker S, Galesic M, Tourangeau R, Yan T. An experimental comparison of Web and telephone surveys. *Public Opinion Quarterly* 2005;69:370-392.

34. Kiernan NE, Kiernan M, Oyler MA, Gilles C. Is a Web survey as effective as a mail survey? A field experiment among computer users. *American Journal of Evaluation* 2005;26:245-252.

35. McCabe SE. Comparison of web and mail surveys in collecting illicit drug use data: A randomized experiment. *Journal of Drug Education* 2004;34:61-72.

36. Dillman DA. *Mail and Internet Surveys: The Tailored Design Method*. 2nd ed. New York: John Wiley & Sons, Inc., 2000.

37. Dohoo I, Martin W, Henrik S. *Veterinary Epidemiologic Research*. Charlottetown, Prince Edward Island, Canada: AVC, Inc., 2003.

38. Hosmer DW, Lemeshow S. *Applied Logistic Regression*. 2nd ed. New York: John Wiley & Sons, Inc., 2000.

APPENDIX A

CAMELID HEALTH AND MANAGEMENT SURVEY

TEXAS CAMELID HEALTH & MANAGEMENT SURVEY

SECTION I. General Information

1. **Name of county where your llama/alpaca herd resides? _____________**
2. **How many years have you owned llamas/alpacas? _________**
3. **Check all activities you participate in with your llamas/alpacas.**

   ☐ Pet ☐ Carting ☐ Guard animal ☐ Pack animal

   ☐ Show or competition ☐ Wool production ☐ Other

____

4. **Do you own llamas?**

   Yes No

   a. **Do you own male llamas?**

      Yes No

      i. Number of MALE llamas **less than 9 months** of age you currently own: _______

      ii. Number of MALE llamas **between 9 months & 2 years** of age you currently own: ________

      iii. Number of MALE llamas **between 3 years & 15 years** of age you currently own: ________

      iv. Number of MALE llamas **more than 15 years** of age you currently own: _______

   b. **Do you own female llamas?**

Yes No

i. Number of FEMALE llamas **less than 9 months** of age you currently own: ______

ii. Number of FEMALE llamas **between 9 months & 2 years** of age you currently own: ______

iii. Number of FEMALE llamas **between 3 years & 15 years** of age you currently own: ______

iv. Number of FEMALE llamas **more than 15 years** of age you currently own: ______

5. Do you own alpacas?

Yes No

a. Do you own male alpacas?

Yes No

i. Number of MALE alpacas **less than 9 months** of age you currently own: _______

ii. Number of MALE alpacas **between 9 months & 2 years** of age you currently own: ______

iii. Number of MALE alpacas **between 3 years & 15 years** of age you currently own ______

iv. Number of MALE alpacas **more than 15 years** of age you currently own: _______

b. Do you own female alpacas?

Yes No

i. Number of FEMALE alpacas **less than 9 months** of age you currently own: ______

ii. Number of FEMALE alpacas **between 9 months & 2 years** of age you currently own _______

iii. Number of FEMALE alpacas **between 3 years & 15 years** of age you currently own ______

iv. Number of FEMALE alpacas **more than 15 years** of age you currently own: _______

SECTION II. General Care of Adult Animals (9 months & Older)

A. GENERAL CARE

6. **Which sources do you most often use for information on llama/alpaca health?**
   - ☐ Other llama/alpaca owners ☐ Veterinarian ☐ Internet
   - ☐ Magazines/newsletters ☐ Associational/industry meetings
   - ☐ Reference books ☐ Other ____________

7. **How many times per year are toenails trimmed on an animal?** _________

8. **Are the fighting teeth usually removed from males?** (Circle One Answer)

   Yes No Do not own males

9. **How often do you shear your animals?** (Circle One Answer)

   Never 1 time per year 2 or more times per year

10. **What domestic animals do the llamas/alpacas come in contact with?**
    - ☐ Cats ☐ Dogs ☐ Cattle ☐ Sheep ☐ Poultry
    - ☐ Goats ☐ Horses ☐ Swine ☐ Other ___________
    - ☐ None

11. **What other non-domestic animals do the llamas/alpacas come in contact with?**
    - ☐ Antelope ☐ Non-native Deer species
    - ☐ Non-domestic Bovids (i.e. Bison) ☐ Ratites (i.e. Emus, Ostriches)
    - ☐ Other _________ ☐ None

12. **What wildlife do the llamas/alpacas come in contact with?**
    - ☐ Deer ☐ Opossum ☐ Mountain Lions ☐ Feral Swine
    - ☐ Raccoons ☐ Coyotes ☐ Bobcats ☐ Other _______
    - ☐ None

B. NUTRITION

13. How do you primarily purchase or obtain concentrated feed? (Circle One Answer)

Not applicable   Retail source   Bulk delivery

Home grown   Other __________

14. How do you primarily purchase or obtain hay/alfalfa? (Circle One Answer)

Not applicable   Retail source   Bulk delivery

Home grown   Other ____________

15. Can the following enter the feed storage area?

☐ Rodents   ☐ Wild birds or poultry   ☐ Cats/dogs

☐ Other __________   ☐ None

C. PREVENTATIVE CARE

16. Which of the following is the primary method of recording llama/alpaca health information? (Circle One Answer)

Computerized records   Hand written records

Records maintained by veterinarian   No health records

17. Are your llamas/alpacas vaccinated?

Yes   No

a. **If no, reasons for not vaccinating?** _________________

b. **If yes, who gives the injection?**

☐ Veterinarian   ☐ Myself   ☐ Other _______________

c. **If yes, where do you obtain the majority of your llama/alpaca vaccines?** (Circle One Answer)

Veterinarian   Feed store or vet supply store   Catalogue

Internet Other ___________

d. If yes, which Vaccinations/Injections do you give your llamas/alpacas?

- ☐ BO-SE Selenium/Vitamin E
- ☐ Vitamin A&D
- ☐ Tetanus Toxoid
- ☐ CONVAC 7-way or 8-way
- ☐ Leptospirosis 5-Way
- ☐ Rabies
- ☐ CDT (Clostridium perfringens C&D + Tetanus)
- ☐ Other ____

18. Do you control for insects (mosquitoes, flies, etc.)?

Yes No

a. If yes, how do you control for insects?

☐ Pour-on ☐ Spray ☐ Other _________________

19. How often is manure removed? (Circle One Answer)

Daily Weekly Monthly Other ___________

20. Has testing for parasites been done for any of your llamas/alpacas within the last year?

Yes No

a. What type of parasite testing is done?

- ☐ Eggs per gram
- ☐ Fecal egg reduction test
- ☐ Drench Rite (larval sensitivity testing)
- ☐ Baermann Test
- ☐ Other _____________

21. Do you regularly use dewormer?

Yes No

a. If yes, why?

- ☐ General preventative measure
- ☐ Worms were seen

☐ Fecal tests results indicated a need ☐ Parasite related illness in the herd

☐ Other ____________________

22. Which dewormers are used?

☐ Ivermectin ☐ Fenbendazole ☐ Pyrantel ☐ Albendazole

☐ Levamisole ☐ Moxidectin ☐ Drug combinations ☐ Other ________

D. REPRODUCTION

23. Do you breed your llamas/alpacas?

Yes No

a. If yes, what breeding strategies do you incorporate?

☐ Field Breeding (male has access to entire herd)

☐ Pen Breeding (1 male & 2-3 females)

☐ Appointment Breeding (1 male & 1 female selected by breeder)

☐ Other ______________________

E. TRAVEL

24. How many times per year do you travel with at least one of your llamas/alpacas? (Circle One Answer)

None 1-2 times 3-4 times

5-10 times 11-20 times 21+ times

a. **Reasons for traveling with your llama/alpaca?**

☐ Show/Competition ☐ Breeding

☐ Recreation/Pack Animal Usage ☐ Veterinary/Health Services

☐ Other ______________

25. What is the maximum distance (in miles) you travel with your llama/alpaca from the ranch/farm? _________

SECTION III. Adult Female Animals (9 months & Older)

Please only include information for FEMALE llamas/alpacas that are 9 months of age and older. **If you do not own any llamas/alpacas that are female and in this age range, skip over this section.**

A. HOUSING

26. How many acres of land are used for the female llamas/alpacas? __________

27. What type of fencing do you use for your female llama/alpaca enclosures?
(Circle One Answer)

Barbed wire Electric Wooden Woven wire Other __________

28. Do female alpacas/llamas have access to shelters at any time?

Yes No

a. If yes, what is the primary shelter provided for female animals?
(Circle One Answer)

Trees 2-sided Shed 3-sided Shed

1-sided Shed Stalls in barn/stable Other _________

C. NUTRITION

29. Drinking water source?

☐ Trough/bucket ☐ Automatic waterer ☐ Pond/reservoir/tank

☐ Stream/spring/river ☐ Other _________

30. Is pasture available to animals?

Yes No

31. With what do you supplement your pastured non-pregnant/non-lactating llama/alpaca's diet?

☐ Nothing ☐ Hay ☐ Concentrate ☐ Other __________

32. What vitamin/mineral supplements do you use for non-pregnant/non-lactating females?

☐ Calcium ☐ Phosphorus ☐ Magnesium ☐ Sodium

☐ Chloride ☐ Copper ☐ Zinc ☐ Selenium

☐ Vitamin E ☐ Salt Lick ☐ Commercial Mineral Mix

☐ Other _____ ☐ None

33. Have you owned any pregnant llamas/alpacas?

Yes No

a. **If yes, with what do you supplement your pastured pregnant llama/alpaca's diet?**

☐ Nothing ☐ Hay ☐ Concentrate ☐ Other _______

b. **If yes, what vitamin/mineral supplements do you use for pregnant females?**

☐ Calcium ☐ Phosphorus ☐ Magnesium ☐ Sodium

☐ Chloride ☐ Copper ☐ Zinc ☐ Selenium

☐ Vitamin E ☐ Salt Lick ☐ Commercial Mineral Mix

☐ Other ______ ☐ None

34. Have you owned any lactating llamas/alpacas?

Yes No

a. **If yes, with what do you supplement your pastured lactating llama/alpaca's diet?**

☐ Nothing ☐ Hay ☐ Concentrate ☐ Other _______

b. **If yes, what vitamin/mineral supplements do you use for lactating females?**

☐ Calcium ☐ Phosphorus ☐ Magnesium ☐ Sodium

☐ Chloride ☐ Copper ☐ Zinc ☐ Selenium

☐ Vitamin E ☐ Salt Lick ☐ Commercial Mineral Mix

☐ Other _______ ☐ None

_

FEMALE HEALTH & DISEASES

For the following questions please include the **female** llamas/alpacas you **currently own** & llamas/alpacas that have **died in the past 3 years**.

Place the number of infected on the line next to each disease. **If none of your llamas/alpacas have been infected then enter "0".**

A. Neurological

35. _____ West Nile Virus

Who diagnosed? ☐ Owner ☐ Veterinarian ☐ Diagnostics Lab

36. _____ Encephalitis

Type? ☐ St. Louis Encephalitis (SLE) ☐ Venezuelan Equine Encephalitis (VEE)

☐ Eastern Equine Encephalitis (EEE)

Who diagnosed? ☐ Owner ☐ Veterinarian ☐ Diagnostics Lab

37. _____ Rabies

Who diagnosed? ☐ Owner ☐ Veterinarian ☐ Diagnostics Lab

38. _____ Tetanus

Who diagnosed? ☐ Owner ☐ Veterinarian ☐ Diagnostics Lab

39. _____ Meningeal Worm

Who diagnosed? ☐ Owner ☐ Veterinarian ☐ Diagnostics Lab

B. Skin

40. _____ Skin Allergies

Who diagnosed? ☐ Owner ☐ Veterinarian ☐ Diagnostics Lab

41. _____ Mites

Type? ☐ Sarcoptes ☐ Chorioptes ☐ Psoroptes ☐ Unknown

Who diagnosed? ☐ Owner ☐ Veterinarian ☐ Diagnostics Lab

42. _____ Zinc-responsive skin disease

Who diagnosed? ☐ Owner ☐ Veterinarian ☐ Diagnostics Lab

43. _____ Malignant Edema

Who diagnosed? ☐ Owner ☐ Veterinarian ☐ Diagnostics Lab

C. Skeletal

44. _____ Extra toes

45. _____ Fused toes

D. Eyes

46. _____ Cataracts

47. _____ Blind

48. _____ Chronic watery eyes

49. _____ Entropian eyelids (inward-folding)

50. _____ Ectropian eyelids (outward-folding)

E. Mouth & Jaw

51. _____ Under-developed lower jaw

52. _____ Over-developed upper jaw

53. _____ Overgrowth of incisors

54. _____ Excessive salivation

F. Ears

55. _____ Deaf

56. _____ Otitis (ear inflammation)

Who diagnosed? ☐ Owner ☐ Veterinarian ☐ Diagnostics Lab

G. Gastrointestinal

57. _____Colic (abdominal pain)

58. _____ *E. coli* Infection

Who diagnosed? ☐ Owner ☐ Veterinarian ☐ Diagnostics Lab

59. ______ Bovine Viral Diarrhea (BVD)

Who diagnosed? ☐ Owner ☐ Veterinarian ☐ Diagnostics Lab

60. ______ Intestinal parasites

Who diagnosed? ☐ Owner ☐ Veterinarian ☐ Diagnostics Lab

H. Other

61. ______ *Streptococcus pyogenes* Infection

Who diagnosed? ☐ Owner ☐ Veterinarian ☐ Diagnostics Lab

62. ______ Listeriosis (*Listeria* infection)

Who diagnosed? ☐ Owner ☐ Veterinarian ☐ Diagnostics Lab

63. ______ Vitamin E – Selenium Deficiency

Who diagnosed? ☐ Owner ☐ Veterinarian ☐ Diagnostics Lab

64. ______ Mycotoxicosis (poisoning by fungi)

Who diagnosed? ☐ Owner ☐ Veterinarian ☐ Diagnostics Lab

65. ______ Heat Stress

66. ______ Liver Flukes

Who diagnosed? ☐ Owner ☐ Veterinarian ☐ Diagnostics Lab

67. ______ Johne's Disease (Paratuberculosis)

Who diagnosed? ☐ Owner ☐ Veterinarian ☐ Diagnostics Lab

68. ______ Mega esophagus

Who diagnosed? ☐ Owner ☐ Veterinarian ☐ Diagnostics Lab

_

FEMALE BREEDING & REPRODUCTION

For the following questions please include the **female** llamas/alpacas you **currently own** & llamas/alpacas that have **died in the past 3 years**.

Place the number of infected on the line next to each disease. **If none of your llamas/alpacas have been infected then enter "0".**

69. Do you breed your female llamas/alpacas?

Yes No

a. How old (years) are females generally when they are bred for the first time?

____

b. Number of your own female llamas/alpacas bred in the past 12 months:

____

c. Number of abortions in the past 12 months: _____

d. Number of stillborn in the past 12 months: _____

e. Number of llama/alpaca crias born in the past 12 months: _____

Number of currently owned adult females with:

70. _____ Imperforated hymen

Who diagnosed? ☐ Owner ☐ Veterinarian ☐ Diagnostics Lab

71. _____ Undeveloped vagina

Who diagnosed? ☐ Owner ☐ Veterinarian ☐ Diagnostics Lab

72. _____ Immature ovary

Who diagnosed? ☐ Owner ☐ Veterinarian ☐ Diagnostics Lab

73. _____ Follicular cysts

Who diagnosed? ☐ Owner ☐ Veterinarian ☐ Diagnostics Lab

74. _____ Rejected cria

75. _____ Low milk production

76. _____ Mastitis (mammary gland infection)

Who diagnosed? ☐ Owner ☐ Veterinarian ☐ Diagnostics Lab

77. _____ Chlamydia

Who diagnosed? ☐ Owner ☐ Veterinarian ☐ Diagnostics Lab

78. _____ Metritis (uterine infection)

Who diagnosed? ☐ Owner ☐ Veterinarian ☐ Diagnostics Lab

79. _____ Uterine Torsion

Who diagnosed? ☐ Owner ☐ Veterinarian ☐ Diagnostics Lab

80. _____ Prolapsed Uterus

Who diagnosed? ☐ Owner ☐ Veterinarian ☐ Diagnostics Lab

81. _____ Caesarian Section

SECTION IV. Adult Male Animals (9 months & Older)

Please only include information for MALE llamas/alpacas that are 9 months of age and older. **If you do not own any llamas/alpacas that are male and in this age range, skip over this section.**

A. HOUSING

82. How many acres of land are used for the male llamas/alpacas? ______

83. What type of fencing do you use for your male llama/alpaca enclosures? (Circle One Answer)

Barbed wire Electric Wooden Woven wire Other ______

84. Do male alpacas/llamas have access to shelters at any time?

Yes No

a. If yes, what is the primary shelter provided for male animals?
(Circle One Answer)

Trees 2-sided Shed 3-sided Shed

1-sided Shed Stalls in barn/stable Other _________

C. NUTRITION

85. Is pasture available to male animals?

Yes No

a. If yes, with what do you supplement your pastured male llama/alpaca's diet?

☐ Nothing ☐ Hay ☐ Concentrate ☐ Other ___________

86. Drinking water source?

☐ Trough/bucket ☐ Automatic waterer ☐ Pond/reservoir/tank

☐ Stream/spring/river ☐ Other _________

87. What vitamin/mineral supplements do you use for males?

☐ Calcium ☐ Phosphorus ☐ Magnesium ☐ Sodium

☐ Chloride ☐ Copper ☐ Zinc ☐ Selenium

☐ Vitamin E ☐ Salt Lick ☐ Commercial Mineral Mix

☐ Other __________________ ☐ None

_

MALE HEALTH & DISEASES

For the following questions please include the **male** llamas/alpacas you **currently own** & llamas/alpacas that have **died in the past 3 years**.

Place the number of infected on the line next to each disease. **If none of your llamas/alpacas have been infected then enter "0".**

A. Neurological

88. _____ Berserk Male Syndrome

Who diagnosed? ☐ Owner ☐ Veterinarian ☐ Diagnostics Lab

89. _____ West Nile Virus

Who diagnosed? ☐ Owner ☐ Veterinarian ☐ Diagnostics Lab

90. _____ Encephalitis

Type? ☐ St. Louis Encephalitis (SLE) ☐ Venezuelan Equine Encephalitis (VEE)

☐ Eastern Equine Encephalitis (EEE)

Who diagnosed? ☐ Owner ☐ Veterinarian ☐ Diagnostics Lab

91. _____ Rabies

Who diagnosed? ☐ Owner ☐ Veterinarian ☐ Diagnostics Lab

92. _____ Tetanus

Who diagnosed? ☐ Owner ☐ Veterinarian ☐ Diagnostics Lab

93. _____ Meningeal Worm

Who diagnosed? ☐ Owner ☐ Veterinarian ☐ Diagnostics Lab

B. Skin

94. _____ Skin Allergies

Who diagnosed? ☐ Owner ☐ Veterinarian ☐ Diagnostics Lab

95. _____ Mites

Type? ☐ Sarcoptes ☐ Chorioptes ☐ Psoroptes ☐ Unknown

Who diagnosed? ☐ Owner ☐ Veterinarian ☐ Diagnostics Lab

96. _____ Zinc-responsive skin disease

Who diagnosed? ☐ Owner ☐ Veterinarian ☐ Diagnostics Lab

97. _____ Malignant Edema

Who diagnosed? ☐ Owner ☐ Veterinarian ☐ Diagnostics Lab

C. Skeletal

98. _____ Extra toes

99. _____ Fused toes

D. Eyes

100. _____ Cataracts

101. _____ Blind

102. _____ Chronic watery eyes

103. _____ Entropian eyelids (inward-folding)

104. _____ Ectropian eyelids (outward-folding)

E. Mouth & Jaw

105. _____ Under-developed lower jaw

106. _____ Over-developed upper jaw

107. _____ Overgrowth of incisors

108. _____ Excessive salivation

F. Ears

109. _____ Deaf

110. _____ Otitis (ear inflammation)

Who diagnosed? ☐ Owner ☐ Veterinarian ☐ Diagnostics Lab

G. Gastrointestinal

111. _____Colic (abdominal pain)

112. _____ *E. coli* Infection

Who diagnosed? ☐ Owner ☐ Veterinarian ☐ Diagnostics Lab

113. _____ Bovine Viral Diarrhea (BVD)

Who diagnosed? ☐ Owner ☐ Veterinarian ☐ Diagnostics Lab

114. _____ Intestinal parasites

Who diagnosed? ☐ Owner ☐ Veterinarian ☐ Diagnostics Lab

H. Other

115. _____ *Streptococcus pyogenes* Infection

Who diagnosed? ☐ Owner ☐ Veterinarian ☐ Diagnostics Lab

116. _____ Listeriosis (*Listeria* infection)

Who diagnosed? ☐ Owner ☐ Veterinarian ☐ Diagnostics Lab

117. _____ Vitamin E – Selenium Deficiency

Who diagnosed? ☐ Owner ☐ Veterinarian ☐ Diagnostics Lab

118. _____ Mycotoxicosis (poisoning by fungi)

Who diagnosed? ☐ Owner ☐ Veterinarian ☐ Diagnostics Lab

119. _____ Heat Stress

120. _____ Liver Flukes

Who diagnosed? ☐ Owner ☐ Veterinarian ☐ Diagnostics Lab

121. _____ Johne's Disease (Paratuberculosis)

Who diagnosed? ☐ Owner ☐ Veterinarian ☐ Diagnostics Lab

122. _____ Mega esophagus

Who diagnosed? ☐ Owner ☐ Veterinarian ☐ Diagnostics Lab

_

MALE BREEDING & REPRODUCTION

For the following questions please include the **male** llamas/alpacas you **currently own** & llamas/alpacas that have **died in the past 3 years**.

Place the number of infected on the line next to each disease. **If none of your llamas/alpacas have been infected then enter "0".**

123. Number of intact males: __________

124. Number of gelded males: __________

125. Do you breed any of your male llamas/alpacas?

Yes No

a. Are intact males kept separated from the herd when not breeding?

Yes No

b. Maximum Age of Breeding Male (years): _________

c. Minimum Age of Breeding Male (years): _________

d. Number of male llamas/alpacas used for breeding in the past 12 months:

____

Number of currently owned adult males with:

126. _____ Undescended testes

127. _____ Uninterested in breeding

128. _____ Poor sperm count

129. _____ Inability to ejaculate

==
=

SECTION V. Crias (Newborn - 8 mos.)

Please only include information for CRIAS that are 8 months of age and younger. **If you do not own any llamas/alpacas that are crias in this age range, skip over this section.**

A. GENERAL CARE

130. Where are crias born?

☐ Open Pasture

☐ Fenced-off area/shelter for only pregnant females & newborns

☐ Fenced area/shelter with other llamas

☐ Other _____________

131. How long do you wait before handling a cria regularly?

☐ Less than an hour ☐ 1-8 hours ☐ 9-24 hours

☐ 2-3 days ☐ 4-7 days ☐ More than a week

132. Do you typically have a veterinarian examine new crias within their first month?

Yes No

B. HOUSING

133. Do crias have access to shelters at any time?

Yes No

a. **If yes, what is the primary shelter provided for crias?**
(Circle ONE Answer)

Trees 2-sided Shed 3-sided Shed

1-sided Shed Stalls in barn/stable Other

____

C. NUTRITION

134. Is pasture available to animals?

Yes No

a. With what do you supplement your cria's diet?

☐ Nothing ☐ Hay ☐ Concentrate ☐ Other ___

135. Drinking water source?

☐ Trough/bucket ☐ Automatic waterer ☐ Pond/reservoir/tank

☐ Stream/spring/river ☐ Other _________

136. What vitamin/mineral supplements do you use for crias?

☐ Calcium ☐ Phosphorus ☐ Magnesium ☐ Sodium

☐ Chloride ☐ Copper ☐ Zinc ☐ Selenium

☐ Vitamin E ☐ Salt Lick ☐ Commercial Mineral Mix

☐ Other __________________ ☐ None

HEALTH & DISEASES

For the following questions please include the **cria** llamas/alpacas you **currently own** & crias that have **died in the past 3 years**.

Place the number of infected on the line next to each disease. **If none of your crias have been infected then enter "0".**

A. Heart

137. _____ PDA (patent ductus arteriosis)

Who diagnosed? ☐ Owner ☐ Veterinarian ☐ Diagnostics Lab

138. _____ Ventricular Septal Defect

Who diagnosed? ☐ Owner ☐ Veterinarian ☐ Diagnostics Lab

B. Neurological

139. _____ Undeveloped cerebellum

Who diagnosed? ☐ Owner ☐ Veterinarian ☐ Diagnostics Lab

140. _____ West Nile Virus

Who diagnosed? ☐ Owner ☐ Veterinarian ☐ Diagnostics Lab

141. _____ Encephalitis

Type? ☐ St. Louis Encephalitis (SLE) ☐ Venezuelan Equine Encephalitis (VEE)

☐ Eastern Equine Encephalitis (EEE)

Who diagnosed? ☐ Owner ☐ Veterinarian ☐ Diagnostics Lab

142. _____ Rabies

Who diagnosed? ☐ Owner ☐ Veterinarian ☐ Diagnostics Lab

143. _____ Tetanus

Who diagnosed? ☐ Owner ☐ Veterinarian ☐ Diagnostics Lab

144. _____ Meningeal Worm

Who diagnosed? ☐ Owner ☐ Veterinarian ☐ Diagnostics Lab

C. Skin

145. _____ Skin Allergies

Who diagnosed? ☐ Owner ☐ Veterinarian ☐ Diagnostics Lab

146. _____ Mites

Type? ☐ Sarcoptes ☐ Chorioptes ☐ Psoroptes ☐ Unknown

Who diagnosed? ☐ Owner ☐ Veterinarian ☐ Diagnostics Lab

147. _____ Zinc-responsive skin disease

Who diagnosed? ☐ Owner ☐ Veterinarian ☐ Diagnostics Lab

148. _____ Malignant Edema

Who diagnosed? ☐ Owner ☐ Veterinarian ☐ Diagnostics Lab

D. Skeletal

149. _____ Extra toes

150. _____ Fused toes

151. _____ Retention of protective toe caps

E. Eyes

152. _____ Cataracts

153. _____ Blind

154. _____ Entropian eyelids (inward folding)

155. _____ Ectropian eyelids (outward folding)

F. Mouth & Jaw

156. _____ Under-developed lower jaw

157. _____ Over-developed upper jaw

158. _____ Absence of erupted incisors

159. _____ Overgrowth of incisors

160. _____ Wry Face

161. _____ Excessive salivation

G. Ears

162. _____ Deaf

163. _____ Otitis (ear inflammation)

Who diagnosed? ☐ Owner ☐ Veterinarian ☐ Diagnostics Lab

H. Gastrointestinal

164. _____ Colic (abdominal pain)

165. _____ Atresia ani (no rectal opening)

166. _____ *E. coli* Infection

Who diagnosed? ☐ Owner ☐ Veterinarian ☐ Diagnostics Lab

167. _____ Bovine Viral Diarrhea (BVD)

Who diagnosed? ☐ Owner ☐ Veterinarian ☐ Diagnostics Lab

168. _____ Intestinal parasites

Who diagnosed? ☐ Owner ☐ Veterinarian ☐ Diagnostics Lab

169. _____ Megaesophagus

Who diagnosed? ☐ Owner ☐ Veterinarian ☐ Diagnostics Lab

I. Reproductive System

170. _____ Cryptorchidism
(retained testicle)

171. _____ Hermaphroditism
(bi-gender animal)

J. Other

172. _____ Premature

173. _____ Poor sucking reflex

174. _____ Weak

175. _____ Choanal atresia (lack of nasal opening in back of oral cavity)

Who diagnosed? ☐ Owner ☐ Veterinarian ☐ Diagnostics Lab

176. _____ *Streptococcus pyogenes* Infection

Who diagnosed? ☐ Owner ☐ Veterinarian ☐ Diagnostics Lab

177. _____ Listeriosis (*Listeria* infection)

Who diagnosed? ☐ Owner ☐ Veterinarian ☐ Diagnostics Lab

178. _____ Vitamin E – Selenium Deficiency

Who diagnosed? ☐ Owner ☐ Veterinarian ☐ Diagnostics Lab

179. _____ Mycotoxicosis (poisoning by fungi)

Who diagnosed? ☐ Owner ☐ Veterinarian ☐ Diagnostics Lab

180. _____ Heat Stress

181. _____ Johne's Disease (Paratuberculosis)

Who diagnosed? ☐ Owner ☐ Veterinarian ☐ Diagnostics Lab

Thank you for taking the survey!
If you have any questions/comments, please contact Brenda Jacklitsch.
Email: bjacklitsch@cvm.tamu.edu

APPENDIX B

COLLINEARITY BETWEEN INDEPENDENT VARIABLES

Table B.1—Table of collinearity for predictor variables (P-values).

	Activity	Attainfeed	Attainhayalf	Breed	Breedtype	Dewormer
Attainfeed	0.456	-	-	-	-	-
Attainhayalf	0.916	0.018	-	-	-	-
Breed	0.001	1.000	0.773	-	-	-
Breedtype	< 0.0001	0.187	0.686	< 0.0001	-	-
Dewormer	0.528	1.000	0.567	0.095	0.509	-
Dewormreas	0.413	0.369	0.642	0.102	0.564	< 0.0001
Dewormertype	0.011	0.198	0.472	0.437	0.326	< 0.0001
Domestic	0.001	0.567	0.002	0.023	0.010	0.509
Fence	0.799	0.199	0.419	0.603	0.709	0.722
Healrec	0.330	0.279	0.617	< 0.0001	0.002	0.768
Info	0.042	0.355	0.477	0.048	0.016	0.111
Injectperson	0.004	0.610	0.771	< 0.0001	< 0.0001	0.151
Insect	0.001	0.666	0.280	0.010	0.190	0.017
Insectprevtype	0.007	0.712	0.382	0.097	0.506	0.060
M_separate	0.014	0.720	0.878	0.179	0.022	0.660
Manure	0.008	0.005	0.982	0.880	0.176	0.487
Nondom	0.626	0.176	0.135	0.593	0.101	0.608
Obt_vacc	0.771	1.000	0.863	0.017	0.011	0.513
Own_camelid	< 0.0001	0.247	0.327	0.046	< 0.0001	0.205
Parasite	< 0.0001	0.506	0.693	0.049	0.005	0.454
Paratest	0.006	0.857	0.664	0.044	0.005	0.188
Pastsupp	0.047	0.894	0.058	0.920	0.473	0.767
Pasture	0.199	0.215	1.000	< 0.0001	0.475	< 0.0001
Primshelter	0.270	0.094	0.821	0.353	0.267	0.891
Shear	0.097	0.779	0.529	0.732	0.797	0.023
Storage	0.740	0.492	0.909	0.578	0.271	0.360
Teeth	0.008	0.333	0.697	0.499	0.433	0.014
Travreas	< 0.0001	0.426	0.944	0.004	< 0.0001	0.161
Vaccnated	0.810	1.000	0.436	0.003	< 0.0001	0.378
Vacctype	0.002	1.000	0.604	< 0.0001	< 0.0001	0.078
Vitsupp	0.101	0.409	0.412	0.032	0.104	0.113
Water	< 0.0001	0.268	0.047	0.284	0.224	0.015
Wildlife	0.023	0.506	0.732	0.633	0.126	0.028
Travel	< 0.0001	0.492	0.770	0.067	< 0.0001	0.122
Maxdistcat	< 0.0001	0.114	0.420	0.006	0.001	0.142
Yrsowncat	0.003	0.549	0.370	0.983	0.116	0.429
Acrescat	0.445	0.526	0.175	0.937	0.052	0.955
toenailscat	0.072	0.097	0.207	0.473	0.002	0.369

	Dewormreas	Dewormertype	Domestic	Fence	Healrec	Info
Dewormertype	< 0.0001	-	-	-	-	-
Domestic	0.363	0.506	-	-	-	-
Fence	0.604	0.600	0.995	-	-	-
Healrec	0.566	0.091	0.208	0.170	-	-
Info	0.414	0.427	< 0.0001	0.186	0.909	-
Injectperson	0.280	0.325	0.102	0.100	< 0.0001	0.005
Insect	0.068	0.162	0.015	0.065	0.305	0.091
Insectprevtype	0.208	0.183	0.314	0.348	0.352	0.598
M_separate	0.718	0.385	0.131	1.000	0.180	0.871
Manure	0.380	0.586	0.245	0.588	0.992	0.079
Nondom	0.891	0.907	0.617	0.169	0.694	0.064

Obt_vacc	0.391	0.765	0.358	0.590	0.022	0.102
Own_camelid	0.054	0.495	0.002	0.224	0.373	0.472
Parasite	0.053	0.222	0.086	0.025	0.081	0.018
Paratest	0.080	0.098	0.105	0.324	0.056	0.059
Pastsupp	0.010	0.686	0.434	0.082	0.762	0.183
Pasture	0.871	0.832	0.027	0.594	0.543	0.673
Primshelter	0.166	0.475	0.298	0.672	0.209	0.082
Shear	0.094	0.077	0.471	1.000	0.444	0.160
Storage	0.628	0.637	0.492	0.076	0.408	0.803
Teeth	0.010	0.103	0.002	0.619	0.324	0.003
Travreas	0.066	0.117	0.016	0.229	0.315	0.007
Vaccinated	0.319	0.387	0.101	0.686	0.113	0.010
Vacctype	0.027	0.339	0.282	0.336	0.002	0.041
Vitsupp	0.016	0.335	0.292	0.244	0.016	0.210
Water	0.202	0.149	0.722	0.050	0.006	0.792
Wildlife	0.168	0.023	0.346	0.023	0.271	0.614
Travel	0.019	0.226	0.108	0.087	0.568	0.003
Maxdistcat	0.010	0.179	0.110	0.720	0.147	0.137
Yrsowncat	0.351	0.027	0.003	0.121	0.828	0.371
Acrescat	0.460	0.267	0.097	0.237	0.761	0.388
toenailscat	0.445	0.680	0.732	0.535	0.080	0.161

	Injectperson	Insect	Insectprevtype	M_separate	Manure	Nondom
Insect	0.012	-	-	-	-	-
Insectprevtype	0.010	< 0.0001	-	-	-	-
M_separate	1.000	0.425	0.818	-	-	-
Manure	0.345	0.023	0.140	0.115	-	-
Nondom	0.661	0.350	1.000	1.000	0.801	-
Obt_vacc	< 0.0001	0.279	0.467	0.509	0.189	0.537
Own_camelid	0.148	0.197	0.180	0.697	0.005	0.721
Parasite	0.676	0.298	0.204	0.712	0.201	0.411
Paratest	0.927	0.704	0.616	1.000	0.132	0.736
Pastsupp	0.312	0.003	0.006	1.000	0.198	0.855
Pasture	0.188	0.572	0.557	1.000	0.392	1.000
Primshelter	0.548	0.840	0.409	0.336	0.167	0.009
Shear	0.885	0.395	0.738	1.000	0.556	0.594
Storage	0.954	0.582	0.185	0.883	0.257	0.063
Teeth	0.005	0.125	0.068	0.513	0.355	1.000
Travreas	0.001	< 0.0001	0.001	0.341	0.017	0.039
Vaccinated	< 0.0001	0.063	0.079	1.000	0.108	0.483
Vacctype	< 0.0001	0.028	0.099	0.149	0.152	0.435
Vitsupp	0.076	0.068	0.401	0.897	0.365	0.338
Water	0.515	0.075	0.183	0.323	0.099	0.120
Wildlife	0.306	0.936	0.379	1.000	0.057	0.115
Travel	0.387	< 0.0001	0.022	0.509	0.081	0.045
Maxdistcat	0.006	< 0.0001	0.019	0.093	0.023	0.390
Yrsowncat	0.857	0.611	0.875	0.262	0.588	0.248
Acrescat	0.080	0.258	0.219	0.935	0.057	0.008
toenailscat	0.129	0.218	0.525	0.783	0.006	0.047

	Obt_vacc	Own_camelid	Parasite	Paratest	Pastsupp	Pasture
Own_camelid	0.795	-	-	-	-	-
Parasite	0.654	0.051	-	-	-	-
Paratest	0.880	0.114	< 0.0001	-	-	-
Pastsupp	0.939	0.543	0.305	0.395	-	-
Pasture	1.000	0.129	0.291	0.084	1.000	-
Primshelter	0.065	0.031	0.208	0.325	0.558	1.000
Shear	1.000	0.002	0.704	0.179	0.158	0.566
Storage	0.307	0.239	0.323	0.859	0.664	0.044
Teeth	0.030	0.577	0.577	0.094	0.217	0.029

Travreas	0.297	0.043	0.069	0.045	0.190	0.640
Vaccnated	< 0.0001	0.877	0.370	0.453	0.798	1.000
Vacctype	< 0.0001	0.525	0.008	0.108	0.846	0.774
Vitsupp	0.529	0.821	0.025	0.231	0.636	1.000
Water	0.247	0.003	0.609	0.113	0.258	0.702
Wildlife	0.557	< 0.0001	0.056	0.117	0.826	0.210
Travel	0.208	0.285	0.004	0.009	0.783	0.246
Maxdistcat	0.497	0.024	0.042	0.043	0.484	0.454
Yrsowncat	0.678	< 0.0001	0.060	0.201	0.635	0.555
Acrescat	0.579	0.070	0.504	0.240	0.831	0.038
toenailscat	0.869	0.025	0.539	0.067	0.486	0.144

	Primshelter	Shear	Storage	Teeth
Shear	0.059	-	-	-
Storage	0.759	0.294	-	-
Teeth	0.578	0.209	0.048	-
Travreas	0.178	0.122	0.132	< 0.0001
Vaccnated	0.194	1.000	0.629	0.242
Vacctype	0.551	0.976	0.247	0.529
Vitsupp	0.259	0.879	0.941	0.394
Water	0.352	0.910	0.774	0.008
Wildlife	0.367	0.679	0.014	0.354
Travel	0.529	0.136	0.287	0.002
Maxdistcat	0.336	0.501	0.249	0.023
Yrsowncat	0.990	0.111	0.088	0.033
Acrescat	0.260	0.810	0.509	0.555
toenailscat	0.734	0.510	0.274	1.000

VITA

Brenda Louise Jacklitsch

Department of Veterinary Integrative Biosciences

c/o Dr. Margaret Slater
College of Veterinary Medicine and Biomedical Science
Texas A&M University
College Station, Texas 77843-4475 U.S.A.

Education: M.S. in Epidemiology, Texas A&M University, Aug. 2007
B.S. in Biomedical Science, Texas A&M University, Dec. 2003

Experience: **Student Research Worker** 8/04-5/07
Dept. of Veterinary Integrative Bioscience, Texas A&M University
Worked for faculty advisor. Generated paper surveys for various pet breeds. Developed surveys, processed mailings, compiled and analyzed data, and wrote reports.
Worked for Dr. Margaret Slater on:

- German Shorthaired Pointer. “A National Breed Health Survey.” (6/06).
- Bouvier Health Foundation. “A National Breed Health Survey.” (9/04 – 9/05).
- English Cocker Spaniel Club of America. “A New Health Survey for the Breed”. (8/04 – 10/04).

Worked for Dr. Geoff Fosgate on:

- Veterinary Student & Practioner Surveys on the interest and need for a background in Epidemiology and Public Health. (10/05 –5/06)

Field Work Assistant 11/05, 2/06, & 2/07
Texas A&M University School of Veterinary Medicine
Sampled ducks and feral pigs to determine bacterial flora.

Zoo Intern 1/04-5/04
Omaha’s Henry Doorly Zoo, Omaha, NE.
Worked as an Animal Care Intern and Reproductive Physiology Intern. Cared for animals in the zoo and wildlife safari park. Performed estrogen hormone assays on fecal samples from a *Dactylopsila trivirgata*. Extracted bovine oocytes for in-vitro maturation. Assisted in sperm counting and in-vitro fertilization of bovine oocytes.