A Study of Bighorn Sheep Diet Composition and Home Range on the Pine Ridge Region of Northwest Nebraska

by

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BIGHORN SHEEP DIET COMPOSITION ON THE PINE RIDGE REGION OF NORTHWEST NEBRASKA

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Abstract: This study was conducted in 2006 and 2007 to determine the diet composition for the Fort Robinson Rocky Mountain bighorn sheep (*Ovis canadensis*) herd located near Crawford, Nebraska. Diet composition was determined from bite count observations and fecal analysis for both ewes and lambs in the herd. The diet during both years was found to be dominated by graminoids (grasses and grass-likes), followed by forbs and then browse. The important graminoids in the diet were sedges, needleandthread, grama/dropseed grasses and June grass. The important forbs were western ragweed, cudweed sagewort, yucca, and hairy goldaster, while the most important browse was fringed sagebrush. However, a seasonal effect was obsedrved in that forbs dominated the diet during the winter months with cudweed sagewort being the most important. Conflicts observed between the bighorn sheep and livestock (cattle, horses and bison) could potentially restrict bighorn habitat and diet as all encounters ended with the bighorn sheep submitting to the livestock. Most encounters occurred around stock tanks livestock could potententially reduce bighorn access to certain grazing areas and alter plant composition in those grazing areas.

Key words: Rocky Mountain bighorn sheep, *Ovis canadensis*, diet composition, competition

INTRODUCTION [1]

In 1981 the Nebraska Game and Parks Commission reintroduced six Rocky Mountain bighorn sheep into a 202-ha enclosure at Fort Robinson State Park near Crawford Nebraska (Fairbanks 1985). The goal of this reintroduction was to reestablish bighorn sheep into their native range because they were extirpated from Nebraska by about 1890 (Grier 1989). The original plan was to create a parent population by expanding the herd to 25 individuals. The parent population would be maintained in the enclosure with additional individuals being released to establish a wild population (Fairbanks 1985). Twenty-one bighorn sheep were released from the enclosure in 1988 with the remaining 23 being released in 1993 when the enclosure was removed. The Nebraska Game and Parks Commission has maintained the Fort Robinson bighorn sheep herd as a free ranging, wild herd, only intervening to add new genetics from other populations since then. Hunting was added as a management tool in 1998 with no more than two tags having been issued in any given year.

1 Format follows: Journal of Wildlife Management

Since the removal of the enclosure, the population slowly increased to just over a hundred individuals in 2003. Contagious ecthyma was confirmed in 2004, killing some lambs. Then for unknown reasons the herd numbers plummeted to around fifty individuals by the summer of 2005. From January to June of 2005, Nebraska Game and Parks Commission staff gathered thirteen bighorn sheep skulls, representing of both sexes, from Fort Robinson State Park. The 2005 lamb crop resulted in sixteen verified births from 22 adult ewes, but by November there were only four lambs alive. No lamb carcasses were discovered during the summer to determine the cause of the reduced numbers.

Previous research conducted at Fort Robinson evaluated habitat for bighorn sheep in the Pine Ridge (Forbes and Merchant 1998), sex-specific habitat selection by low elevation bighorn sheep (Klinksiek 2004), and lambing sites for the bighorn sheep in the Pine Ridge (Powers 2006). However, research evaluating diet composition of the bighorn sheep population following the release from the enclosure has not been conducted. Therefore, the specific objectives of this research were:

(1) Establish baseline seasonal foraging preferences of the Fort Robinson bighorn sheep,

- Quantify species selected by bighorn sheep throughout the calendar year

(2) Explore habitat/forage competition with other herbivores.

- Quantify the occurrence of forage overlap between bighorn sheep and other ungulates throughout the calendar year.
- Quantify the number of times cattle or horses chase bighorn sheep from water and salt licks throughout the calendar year.

LITERATURE REVIEW

Bighorn Sheep Diet

According to Geist (1971), "One can conceive of mountain sheep as generalized mountaineers and specialized grazers, adapted to the boom and bust economy of the north…. They feed selectively, plucking or pulling rather than biting off vegetation." A common thread can be established for a bighorn sheep's diet by looking through the dietary literature. Rocky Mountain bighorn sheep are considered grazers, thus it makes sense that graminoids, grasses, typically dominate their diet. For simplicity grasslikes, such as sedges will be included with graminoids. The contribution of graminoids to the diet composition seems to typically vary from 57% to 98% (Blood 1967, Oldemeyer et al. 1971, Brown and Yde 1988, Goodson et al. 1991a & 1991b). The next major group of plants to contribute to the diet composition depends on what herd/location is under review. In some instances browses seem to be more dominant than forbs, while in other circumstances forbs may dominate browses or they can be fairly equal in the diet composition (Rominger et al. 1988, Nordeen 2006). It also needs to be kept in mind that many factors, such as the season, weather conditions, and plant community being utilized influences a bighorn sheep's diet.

According to the literature the main graminoid species being utilized bythe bighorns are bluebunch wheatgrass[2] (*Agropyron spicatum* (Pursh) Scribn. & Sm.), Idaho fescue (*Festuca idahonesis* Elmer), Junegrass (*Koeleria cristata* (Lam.) Beauv.), bluegrass (*Poa spp*. L.), needlegrasses (*Stipa spp*. L.), bromes (*Bromus spp.* L.), and sedges (*Carex spp.* L.). The main browse plants are sagebrush (*Artemisia spp.* L.), yucca (*Yucca glauca* Nutt.) and winterfat (*Ceratoides lanata* (Pursh.) Howell), while forbs consumption consist mainly of phlox (*Phlox*

2 Nomenclature follows: Flora of the Great Plains (McGregor et al. 1986)

spp. L.) and yarrow (*Achillea millefolium* L.) (Blood 1967, Demarchi 1968, Oldemeyer et al. 1971, Todd 1975, Keating et al. 1985, Nordeen 2007).

During the winter months (December through February), Rocky Mountain bighorn sheep diets are typically dominated by graminoids, which can vary from 61.4% to 96% of the diet (Oldemeyer et al. 1971, Brown and Yde 1988, Goodson et al. 1991a). The high percentages of graminoids in the diet is explained by the graminoids being partly green throughout winter and rapidly greening up in March, whereas most forbs and shrubs do not began spring growth until April (Goodson et al. 1991a). Oldemeyer et al.'s (1971) study, in the northern one fifth of Yellowstone National Park, showed that bluebunch wheatgrass was the most important forage at 24.5%. Important graminoids reported to be selected in winter according to other researchers were wheatgrass (*Agropyron spp.* Gaertn.), bluebunch wheatgrass, needlegrasses, needleandthread grass (*Stipa comata* Trin. & Rupr.), Junegrass, sedge, fescues (*Festuca spp.* L.), Idaho fescue, and bromes (Oldemeyer et al. 1971, Keating et al. 1985). In contrast Todd (1975 found that shrubs dominated the winter diet of a herd in southern Colorado.

Goodson and co-worker's (1991a) study, in north central Colorado, suggests that forbs are the next most important plant group in winter diet at 8%. While Brown and Yde's (1988) study in northwestern Montana and Oldemeyer and co-worker's (1971) study in the northern Yellowstone National Park, suggests that shrubs are the next important plant in the diet with 34% and 21.5% respectively. The important shrubs in the winter diet consisted of fringed sagebrush (*Artemisia frigida* Willd.), winterfat, douglas rabbitbrush (*Chrysothamnus viscidiflorus* (Nutt.) Hook.), while the forbs consisted of phlox, and yarrow (Oldemeyer et al. 1971, Keating et al. 1985).

Goodson and co-workers (1991b) also studied effects of snow on foraging ecology and nutrition of bighorn sheep on the boundary of Rocky Mountain National Park, located in north central Colorado. The diet composition was: graminoids 91%, browse 5%, and forbs 4%. The high amount of graminoides suggests that sheep tend to stay in areas were snow is the shallowest.

Spring diets for the Ural-Tweed bighorn sheep population in northwestern Montana were similar to their winter diet with graminoids contributing 62%, browse 28%, and forbs 10% (Brown and Yde 1988). Todd's (1975) study in southern Colorado also agrees that grasses and sedges became the important forage in the spring diet. Nordeen's (2007) study, on a low elevation herd in northwest Nebraska, revealed that two plant species, the graminoid blackroot sedge (*Carex filifolia* Nutt.) and the forb penstemon (*Penstemon spp.* Mitchell), dominated the spring diet while both the forb sandwort (*Arenaria hookeri* (Nutt. *ex* T. & G.) and the shrub yucca were secondary.

Summer diets for bighorn sheep in northwestern Montana are dominated by graminoids at 57%, browse 28%, and forbs 15% (Brown and Yde 1988). Todd's (1975) data from southern Colorado supports Brown and Yde's (1988) statement that grasses and sedges dominate the summer diet. Nordeen's (2007) study of the low elevation sheep in Nebraska showed equal diet composition between graminoids and browse in the summer diet, which were graminoids blackroot sedge, hairy grama (*Bouteloua hirsuta* Lag.), sand bluestem (*Andropogon hallii* Hack), and the shrub skunkbrush sumac (*Rhus aromatica* Ait.).

In contrast to all other articles, Rominger and associates (1988) studied the importance of shrubs in the summer diet of bighorn sheep at Waterton Canyon, near Denver Colorado. This bighorn sheep herd is an indigenous low-elevation herd. They discovered that shrubs dominated

the summer diet of bighorn sheep by 81%, with true mountainmahogany (*Cercocarpus montanus* Raf.) being the main shrub utilized, while graminoids and forbs made up the remainder of the diet. The reason for this maybe because true mountainmahogany leaves contain 11.2-16.3% crude protein and 33.4-38.7% in-vitro digestible organic matter (Rominger et al. 1988).

Fall diets from the northwestern part of Montana were again dominated by graminoids at 78%, browse 19%, and forbs 3% (Brown and Yde 1988), which Todd's (1975) study in southern Colorado further supports. Nordeen (2007) also observed that graminoids dominate the fall diet with browse being second from his study of a low elevation herd in northwest Nebraska. The most important fall plants in Nordeen's (2007) study were downy brome (*Bromus tectorum* L.), needleandthread, Russian olive (*Elaeagnus angustifolia* L.) and winterfat.

Diet Competition

Since bighorn sheep are not the only ungulates in North America there is a potential that their diet could overlap with other wildlife or livestock. Rocky Mountain bighorn sheep are considered grazers; therefore, it is more likely that their diets would overlap with deer, elk, bison, cattle and maybe horses.

Livestock. - Krysl and co-workers (1984) studied the dietary overlap of horses and cattle in the Red Desert of Wyoming. They found that horses' and cattle's diets overlap an average 72% of the time in summer and 84% of the time in the winter. The horses' diet consisted of blackroot sedge, Junegrass, needleandthread, wheatgrass and bluegrass species (Krysl et al. 1984). Cattle diets consist of the same types of grasses and sedges as the horses', but cattle tended to consume more shrubs than horses (Krysl et al. 1984). Volesky and associates (2007) studied cattle grazing in the Sandhills of Nebraska and found the same plant species being consumed. Similar to horse and cattle diets, domesticated bison, diets are dominated by grasses

and sedges (Vuren 1984). Since horses, cattle and bison diets are mainly dominated by graminoids (grasses and grasslikes), there is a good potential for dietary overlap with bighorn sheep

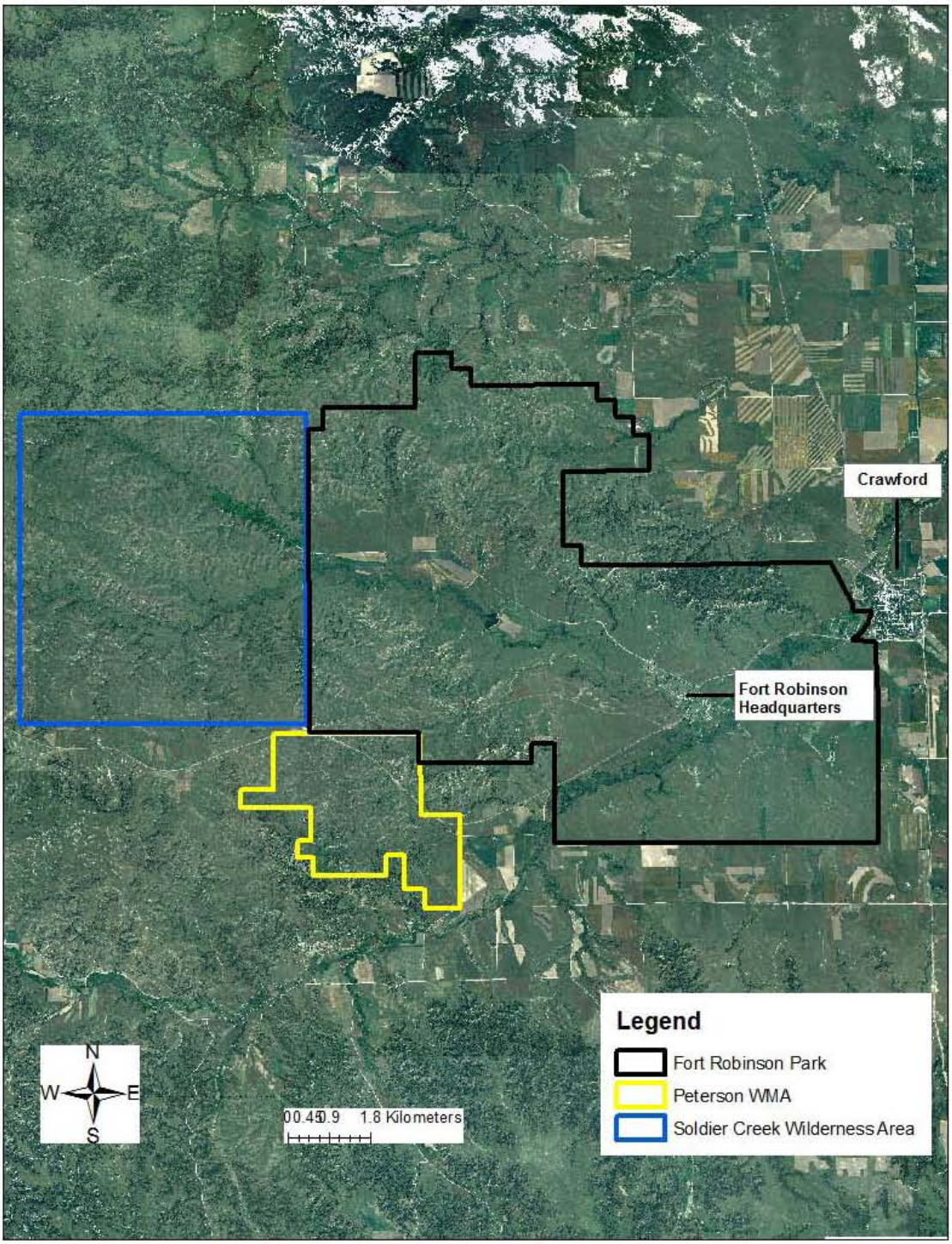
Wildlife. – Van Dyne and co-workers (1980) found that a mule deer's diet is generally comprised of shrubs and trees, followed by forbs and then grass (59%, 28%, and 13% respectively). Similar to the mule deer diet, white-tail deer diets are also dominated by shrubs, forbs and grass (generally 60%, 30%, and 10% respectively) (Van Dyne et al. 1980). According to Van Dyne and co-workers (1980), an elk's diet is opposite both the white tail and mule deer diets with 69% grasses, 14% forbs and 17% shrubs. As for pronghorn diets, they mainly prefer forbs, then shrubs and seldomly eat grasses (Krausmen 1996). Thus the primary dietary overlap bighorn sheep would have with other wildlife would be with elk, since their diet consists of mianly grasses.

METHODS

Study Area

The study was conducted at Fort Robinson State Park (42°39'59.9", 103°27'55.9"), located approximately 4.8 kilometers west of Crawford, Nebraska, in Sioux and Dawes Counties. The area lies within the Pine Ridge escarpment in the Northwest part of the Nebraska panhandle. Fort Robinson State Park is roughly 16,322 ha, which varies in topography from gently rolling hills to rugged buttes and rang in elevation from 1,132m to 1,491m (Fairbanks 1985, Klinksiek 2004). The study area included Soldier Creek Wilderness Area (42°41'47.6", 103°34'08.8") which borders Fort Robinson on the west, Peterson Wildlife Management Area (42°38'33.5", 103°31'51.0") adjacent to the south and private lands adjacent to the Fort (Figure 1).

Figure 1. The boundaries of the study area at Fort Robinson State Park, Crawford Nebraska, USA.



The climate at Fort Robinson is typically warm in the summers with periods of very cold weather in the winters. The average maximum temperature for summer and winter are 31°C and 3°C respectively. The temperature extremes of the area are 43°C and -37°C. Annual precipitation for the area is 44 centimeters with the heaviest precipitation generally falling in the spring to early summer months. Snowfall is usually frequent throughout the winter; with snow cover dissipating during mild periods. All weather records are taken from the weather station at Fort Robinson (High Plains Regional Climate Center 2007).

The Fort Robinson area is considered an open grassland savanna dominated by blue grama (*Bouteloua gracilis* (H.B.K.) Lag. *ex* Griffiths), little bluestem *(Schizachyrium scoparium* Michx.), western wheatgrass (*Agropyron smithii* Rydb.), needleandthread grass, blackroot sedge, sand bluestem, sideoats grama (*Bouteloua curtipendula* (Michx.) Torr.), bluegrass, green needlegrass (*Stipa viridula* Trin.), prairie sandreed (*Calamovilfa longifolia* (Hook.) Scribn.), western snowberry (*Symphoricarpos occidentalis* Hook.), skunkbrush sumac, chokecherry (*Prunus virginiana* L.), and ponderosa pine (*Pinus ponderosa* Laws). The most prominent soils at Fort Robinson are Tassel-Ponderosa-Rock outcrop association and Ponderosa-Tassel-Vetal complex (United States Department of Agriculture 1977).

Capture

Radio telemetry was the primary means of locating marked individuals for field observations. In July 2006, there were twelve ewes marked with ear tags and radio collars, with only five of the collars working consistently. In January 2007, Quicksilver Aviation Inc. was hired to capture twenty-four individuals (19 ewes, 5 rams). The sheep were net gunned via helicopter, once captured they were blindfolded and hobbled to ensure the sheep's and biologist's safety. They were then transported to the eastern fence line of the park, where

biological samples were taken by Nebraska's Game and Parks wildlife biologists. New collars and ear tags were put on, then the sheep were releaseed.

Body temperature was monitored throughout sampling via a rectal thermometer. If body temperature went above 41°C, water and rubbing alcohol were applied on the abdomen to cool the animal as bighorn sheep can suffer from capture myopathy if body temperature reachs 42°C to 43°C. If a sheep's temperature was not brought below 41°C, no samples were taken and the sheep was released as quickly as possible. Some bighorn sheep that were caught had an old collar, thus these were replaced with a new one. Fecal, hair, ear notch, blood and hoof samples were obtained from individuals with acceptable body temperatures. Fecal samples were utilized to test of lungworm concentrations. The ear notch along with hair from above the tail and between the hooves were collected for DNA analysis. Blood was drawn to test for Epizootic Hemorrhagic Disease. Hoof samples were collected to establish base line data for comparison to data from sheep with hoof deformities (Nordeen 2007).

Vegetation surveys

Bighorn sheep locations from 2005 and 2006 were analyzed to identify occupancy and distribution patterns throughout the study area. From these analysis three areas, Smiley Canyon, Mexican Canyon and Saddle Rock Flats (Figure 2) were identified as heavily used areas. Vegetation transects were then established for comparison of the areas (Appendix 3A). On each heavily used area, transects were randomly located on three topographic stratifications of top, side slope and bottom of the buttes. On Smiley Canyon, five transects were established with Transect ST1 on top, Transect ST2 on the side slope and Transects WT1, WT2, & WT3 on the bottom (Figure 3). Mexican Canyon had two transects, with Transect MT1 on top and Transect MT2 on the side slope (Figure 3). Saddle Rock Flats had four transects established with

Figure 2. Vegetation survey areas at Fort Robinson State Park, Crawford Nebraska, USA.

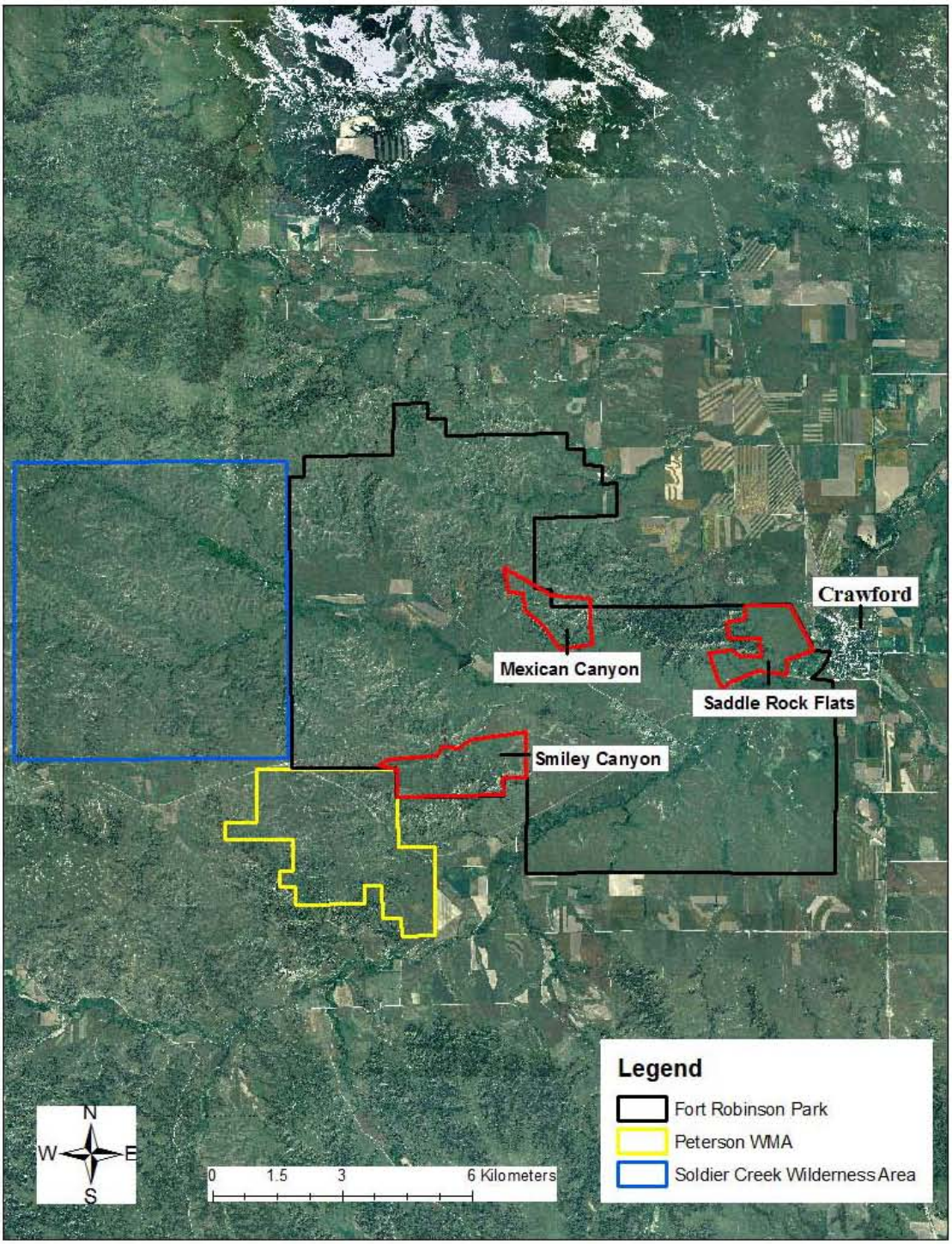
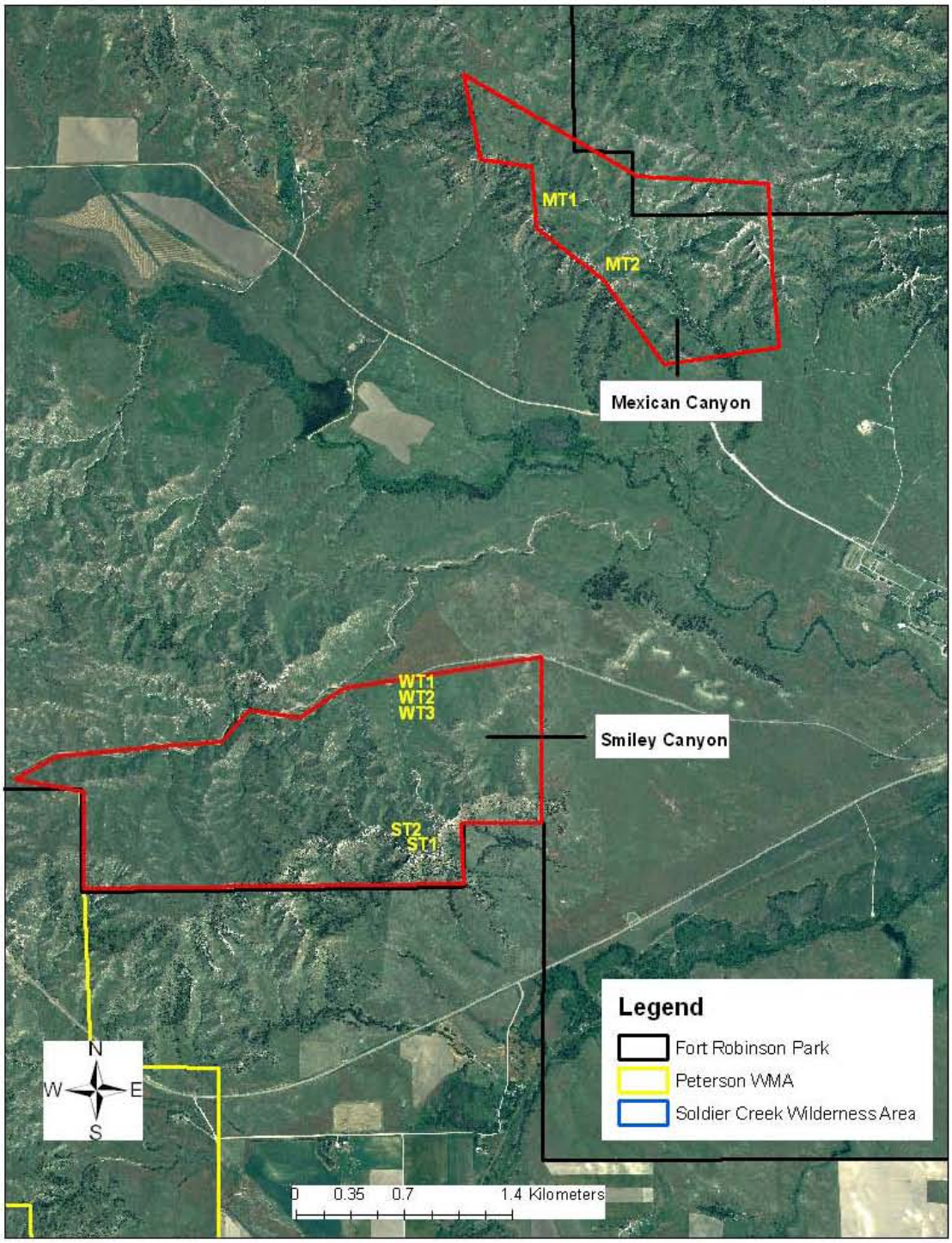


Figure 3. Vegetation transects on Smiley Canyon and Mexican Canyon at Fort Robinson State Park, Crawford Nebraska, USA.



Transects FT1 & FT3 on the side slope, and Transects FT2 & FT4 on the bottom (Figure 4). Plant frequency data and percent green was collected from each transects. The distances between frames varied with the length of transect. A one-meter circular frame was used for each plot for all transects. At each plot, each species of plant was identified within that circular frame. Data was collected on the transects in March (late winter), May (spring), July (summer) and October (fall) of 2007 to encompass the entire growing season of late winter, spring, summer and fall respectively (Appendix A4).

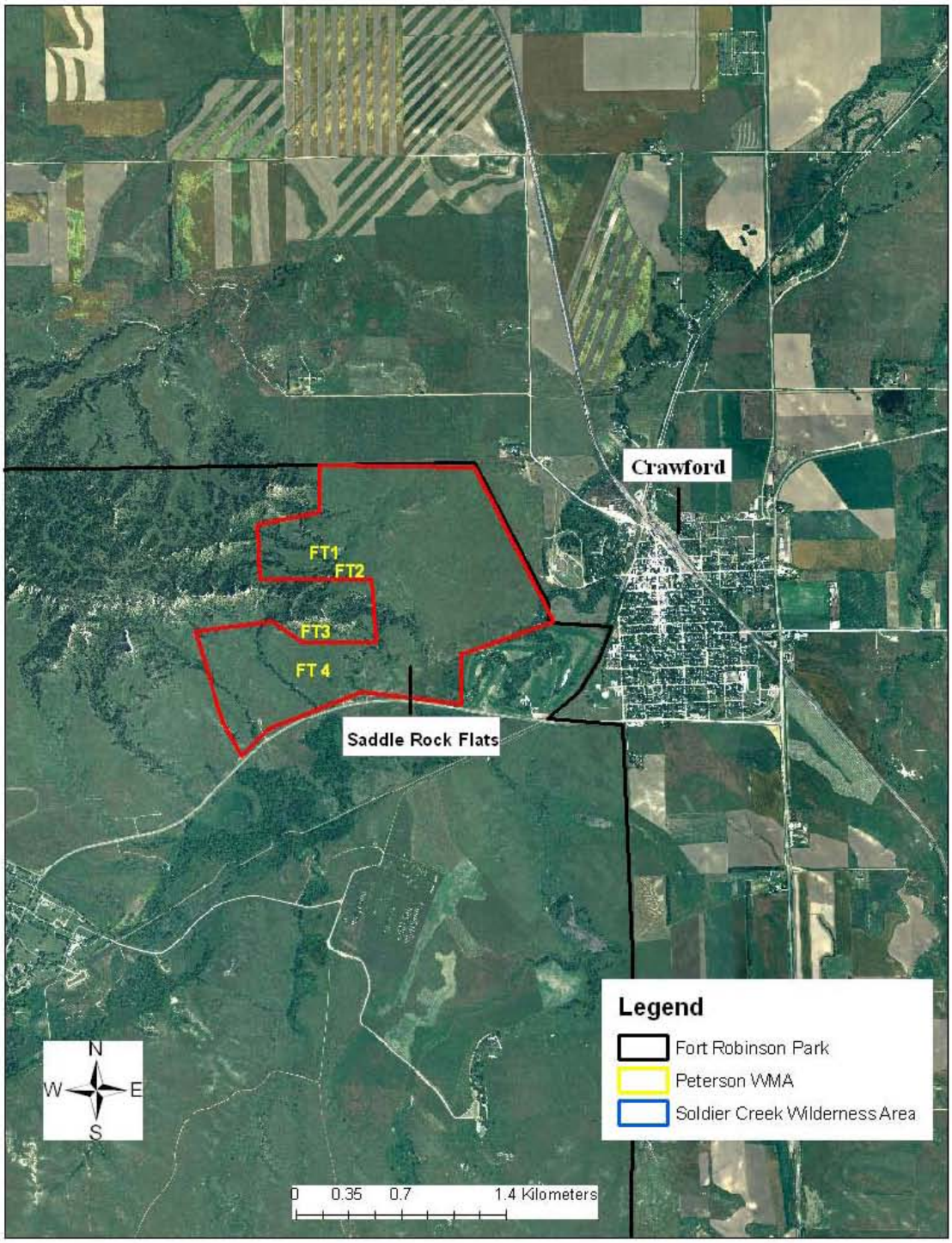
Diet

For this study, grass-like plants were combined with grasses (graminoids) to be consistant with the literature. Diet composition was broken down by species of plants determined through bite count observation, grab samples and microhistological analysis (Keating et al. 1985, Rominger et al. 1988). A Microhistological analysis identifies plant material fragments in ground up fecal samples and reports it as percent relative density. The percent relative density was based on 2 slides of 20 fields per sample by the Microhistiological lab of Fort Collins, Colorado.

Sanders and assocaites (1980) proved that both bite-count and fecal analysis methods give similar results for estimating cattle diets in Texas. Ten fecal samples (from both ewes and lambs) were collected, within 4 hours of defecation, each week of every month for two full calendar years. Samples will be randomly collected from different sheep within the herd.

Ten bite count observations were conducted each month for two full calendar years. Bite counts were conducted whenever an opportunity presented itself (when sheep are not on the move or stressed by the observers presence), randomly targeting different sheep in the herd. This will help determine plant species preference and percentage consumed by selected ewes and

Figure 4. Vegetation transects on Saddle Rock Flats at Fort Robinson State Park, Crawford Nebraska, USA.



lambs. Each observation will last 2-10 minutes recording each bite by plant species. A bite constitutes when a sheep makes a jerking motion either up or down with its head, (Rominger et al. 1988). After the sheep have moved off the location of grazing, the vegetation that was under the grazing pressure will be assessed to verify the correct plant specie or species that were recorded in the bite count. Grab samples of the selected plant species were collected in case the microhistiological laboratory in Fort Collins, Colorado needed them to aid in the microhistological analysis of the fecal samples.

During field observations of the bighorn sheep, any behavioral conflicts between livestock or wildlife and bighorn sheep were documented. Competition around water, salt licks, or forage were the primary focus. No indirect competition, such as diet overlap, was focused on during this study.

RESULTS

Vegetation Transects

The vegetation transects from the four seasons were first compiled into percentages. Then the percentages for the four seasons of late winter, spring, summer and fall were averaged for easier interpretation. Cool season plants heavily dominated the top of Mexican Canyon (south facing). This area was in a lower serial state, which was heavily dominated by the non-native specie downy brome (68%) (Table 1). The top of Mexican Canyon was gently rolling topography, which was accessible to grazing by livestock (horses and cattle) and wildlife. This area appeared to be grazed by livestock in a low intensity year long duration, which could contribute to the low seral/diversity cool season system.

Table 1. Vegetation frequency at the top of Mexican Canyon at Fort Robinson State Park, Nebraska in 2007.

Plant Name	Averaged Frequency
downy brome	**68%**
sun sedge	**48%**
needleandthread	**45%**
prairie sandreed	**41%**
western ragweed	**37%**
Kentucky bluegrass	**31%**
Japanese brome	**27%**
wheatgrass	**26%**
blackroot	**22%**
white aster	**20%**
fringed sagebrush	**19%**
sand bluestem	**19%**
scarlet gaura	**14%**
Junegrass	**12%**
hairy goldaster	**11%**

Similar to the top, the Mexican Canyon side slope (north facing) was also a cool season dominated plant community. This system was dominated by sun sedge (*Carex heliophola*) (41%), while downy brome was the second frequent plant with 35% (Table 2). There was more plant diversity in this area than the top because of the reduced levels of downy brome, Japanese brome and Kentucky bluegrass. Livestock utilization of this side slope was poor, which may contribute to the higher plant diversity.

Table 2. Vegetation frequency on the side slope of Mexican Canyon at Fort Robinson State Park, Nebraska in 2007.

Plant Name	Averaged Frequency
sun sedge	**41%**
downy brome	**35%**
wheatgrass	**31%**
sideoats grama	**30%**
white aster	**29%**
fringed sagebrush	**28%**
needleandthread	**26%**
Kentucky bluegrass	**21%**
goldenrod	**17%**
chokecherry	**16%**
cudweed sagewort	**14%**
desert stickseed	**13%**
golden pea	**13%**
blackroot	**12%**
Rockymountain beeplant	**12%**
field chickweed	**11%**
snowberry	**10%**
prairie sandreed	**10%**

The top of Smiley Canyon (north facing slope) was heavily dominated by cool-season graminoids, mainly sun sedge (48%). This site had some native plant diversity, but there were still an abundance of non-native plants present (Table 3). The high abundance of Kentucky bluegrass and smooth brome indicates that this was also a low seral community. This area was

grazed (by horses) in a high intensity, long-duration grazing, typically from November to May, though the horses was rarely seen in this area of the pasture.

Table 3. Vegetation frequency at the top of Smiley Canyon at Fort Robinson State Park, Nebraska in 2007.

Plant Name	Averaged Frequency
sun sedge	**48%**
Kentucky bluegrass	**45%**
needleandthread	**33%**
smooth brome	**33%**
wheatgrass	**25%**
Junegrass	**24%**
fringed sagebrush	**23%**
prairie sandreed	**23%**
white aster	**20%**
little bluestem	**19%**
downy brome	**18%**
western ragweed	**16%**
blackroot	**14%**
puccoon	**11%**
skeletonweed	**10%**
goat's beard	**10%**

The side slope of Smiley Canyon (north facing) had high concentrations of sun sedge (54%) and white aster (53%), but was mainly dominated by forbs; white aster (*Aster ericoides*), goldenrod (*Solidago spp.*), golden pea (*Thermopsis rhombifolia*), and field chickweed (*Cerastium arvense*). This area exhibited good plant diversity with a mixture of forbs, grasses and some browse (Table 4). The lower frequency of smooth brome and Kentucky bluegrass combined with the good native plant diversity indicates that this community was in a mid seral state. The higher plant diversity could be explained by the moister microclimate that north-facing slopes typically have.

Table 4. Vegetation frequency on the side slope of Smiley Canyon at Fort Robinson State Park, Nebraska in 2007.

Plant Name	Averaged Frequency
sun sedge	**54%**
white aster	**53%**
goldenrod	**46%**
hairy goldaster	**38%**
fringed sagebrush	**36%**
golden pea	**34%**
needleandthread	**34%**
snowberry	**29%**
field chickweed	**26%**
smooth brome	**25%**
wheatgrass	**25%**
gayfeather	**22%**
Kentucky bluegrass	**20%**
puccoon	**19%**
hare bell	**15%**
Junegrass	**15%**
yucca	**13%**
prairie thermopsis	**11%**
blackroot	**10%**

The bottom of Smiley Canyon (north facing) was in a lower seral state. The bottom of Smiley Canyon consisted of three vegetation transects; working from the roadside towards the Smiley Canyon buttes (south), a slight change in plant diversity could be noticed (Table 5, 6, and 7 respectively). The bottom was heavily dominated by downy brome (89%), but also had many plant species typically found in poor range sites, such as western ragweed, tumble mustard (*Sisymbrium altissimum* L.), and peppergrass (*Lepidium spp.* L.) (Table 5). The plant diversity was also very low in the bottom, while the native plant species were almost completely removed from certain areas. The main reason for the lower seral state was due to the over grazing of horses. The horses were grazed at a high intensity for a long-duration in this pasture. Since the windmill on this area was the only water in the pasture and the salt was dropped near the windmill, the area was heavily used.

Table 5. Vegetation frequency on the bottom of Smiley Canyon near the road at Fort Robinson State Park, Nebraska in 2007.

Plant Name	Averaged Frequency
downy brome	**89%**
wheatgrass	**73%**
Japanese brome	**31%**
sun sedge	**29%**
needleandthread	**29%**
western ragweed	**23%**
scarlet globemallow	**21%**
Virginia groundcherry	**16%**
skeletonweed	**16%**
tumble mustard	**14%**
sweetclover	**14%**
peppergrass	**11%**

Table 6. Vegetation frequency on the bottom of Smiley Canyon in the middle of the pasture at Fort Robinson State Park, Nebraska in 2007.

Plant Name	Averaged Frequency
downy brome	**60%**
sun sedge	**58%**
needleandthread	**56%**
Japanese brome	**43%**
wheatgrass	**41%**
Kentucky bluegrass	**36%**
western ragweed	**30%**
scarlet globemallow	**20%**
fringed sagebrush	**15%**
sand dropseed	**13%**
Scribners panicum	**11%**
puccoon	**10%**

Table 7. Vegetation frequency on the bottom of Smiley Canyon near the butte at Fort Robinson State Park, Nebraska in 2007.

Plant Name	Averaged Frequency
wheatgrass	**64%**
sun sedge	**58%**
needleandthread	**38%**
Kentucky bluegrass	**31%**
downy brome	**29%**
prairie sandreed	**24%**
Japanese brome	**19%**
fringed sagebrush	**18%**
sand dropseed	**15%**
white aster	**9%**

The Lover's Leap side slope (south facing slope) was dominated by blackroot sedge (80%), and again was mainly a cool season community (Table 8). There was good plant diversity within this area, but again a high frequency of non-native species. Since this was a south facing slope it would be expected to be a warm season community. This was a gentle rising slope that was favorable to grazing (cattle), which was a low intensity long-duration rotation. The high frequency of fringed sagebrush, sand sagebrush, yucca and the non-native plant species indicate that this pasture is shifting to a lower seral state.

Table 8. Vegetation frequency on the side slope of Lover's Leap at Fort Robinson State Park, Nebraska in 2007.

Plant Name	Averaged Frequency
blackroot	**80%**
Junegrass	**49%**
needleandthread	**44%**
fringed sagebrush	**41%**
downy brome	**40%**
western ragweed	**36%**
Japanese brome	**32%**
Kentucky bluegrass	**29%**
prairie sandreed	**20%**
yucca	**17%**
wheatgrass	**15%**
American vetch	**15%**
sand sagebrush	**15%**
scarlet globemallow	**14%**
white aster	**13%**
silverleaf scurfpea	**12%**
goat's beard	**11%**

The Saddle Rock side slope (south facing slope) was dominated by sideoats grama (45%), but the majority of the plant diversity was cool season (Table 9). There was poor plant diversity as well as having a high frequency of downy brome, which demonstrates a low seral state. This slope was too steep for any favorable grazing (cattle), which was a low intensity long duration rotation.

Table 9. Vegetation frequency on the side slope of Saddle Rock at Fort Robinson State Park, Nebraska in 2007.

Plant Name	Averaged Frequency
sideoats grama	**45%**
desert stickseed	**35%**
wheatgrass	**33%**
needleandthread	**30%**
fringed sagebrush	**29%**
downy brome	**28%**
yucca	**17%**
scarlet gaura	**15%**
silverleaf scurfpea	**15%**
Russian thistle	**14%**
blue grama	**13%**
tumble mustard	**10%**

The Saddle Rock Flats bottom (east facing valley) was a cool season system dominated by blackroot (60%) (Table 10). The plant diversity was moderate to good with various grasses, forbs and browse. The area was in a lower to mid seral state because there was still a high frequency of non-native plant species within the plant diversity. The Saddle Rock Flats bottom was also grazed by cattle in a low intensity long-duration rotation, which contributes to the invasion of the non-native species.

Table 10. Vegetation frequency on the bottom (valley) of Saddle Rock Flats at Fort Robinson State Park, Nebraska in 2007.

Plant Name	Averaged Frequency
blackroot	**60%**
fringed sagebrush	**50%**
needleandthread	**48%**
Japanese brome	**37%**
Junegrass	**34%**
downy brome	**29%**
whorled milkweed	**23%**
Kentucky bluegrass	**22%**
yucca	**22%**
scarlet globemallow	**19%**
sand sagebrush	**18%**
prairie sandreed	**17%**
wheatgrass	**16%**
blue grama	**13%**
puccoon	**12%**
woolly plantain	**11%**
white aster	**10%**

The Saddle Rock Flats bottom (south side of Saddle Rock Butte) was also dominated by cool season plants, which were needleandthread (63%), downy brome (60%) and blackroot (60%) (Table 11). The plant diversity in this area was less than in the Saddle Rock Flats valley. The non-native plants combined with the lower plant diversity shows this area was in a low seral state. The Saddle Rock Flats bottom area was grazed by cattle in a low intensity long-duration rotation.

Table 11. Vegetation frequency on the bottom (highway side) of Saddle Rock Flats at Fort Robinson State Park, Nebraska in 2007.

Plant Name	Averaged Frequency
needleandthread	**63%**
downy brome	**60%**
blackroot	**60%**
Kentuck bluegrass	**36%**
Japanese brome	**28%**
wheatgrass	**27%**
yucca	**22%**
Junegrass	**20%**
prairie sandreed	**18%**
blue grama	**18%**
sand sagebrush	**11%**
goat's beard	**10%**

Diet

Bite count observations were gathered throughout the two years of the study, but microhistiological samples were only collected for the first year. The bite counts were combined in a seasonal breakdown: spring (March, April, and May), summer (June, July, and August), fall (September, October, and November,), and winter (December, January, and February). Reviewing the data seasonally revealed a change in diet between seasons and between the two seasons (2006 & 2007).[3]

Spring. - The 2006 spring bite counts revealed ewes (13 bite counts) and lambs (1 bite count) primarily foraged on graminoids followed by browse and then forbs. The most important graminoids selected for were blackroot and wheatgrass. The important browse species were fringed sagebrush and yucca and the one forb was phlox (Table 12). While the 2007 spring bite counts indicated that forbs were the only forage ewes selected for (Table 13). Phlox was the only forb consistent with 2006, the other plant species in the 2007 bite counts were alfalfa (*Medicago spp*. L.), goldenrod and puccoon (*Lithospermum canescens* (Michx.) Lehm.). No bite counts were observed on the lambs in 2007.

3 Refer to appendix A5 for complete bite count charts.

Table 12. Bighorn sheep bite counts at Fort Robinson State Park, Nebraska in the spring of 2006.

Plant Name	Ewe	Lamb
wheatgrass spp.	50%	-
blackroot	32%	100%
fringed sagebrush	9%	-
phlox	8%	-
yucca	1%	-

Table 13. Bighorn sheep bite counts at Fort Robinson State Park, Nebraska in the spring of 2007.

Plant Name	Ewe	Lamb
phlox	44%	-
puccoon	40%	-
alfalfa	15%	-
goldenrod spp.	1%	-

Similar to the 2006 bite count, the 2006 spring microhistiological samples (10 ewe samples) indicated that the ewe's diet was dominated by graminoids, which was followed by browse (Table 14). Similar to the bite count, sedges was very prominent in the diet. Unlike the bite count, needleandthread and grama/dropseed grasses were also important graminoids. The only important browse was fringed sagebrush. There were no microhistiological samples collected for the lambs for this season.

Table 14. Bighorn sheep microhistiological results at Fort Robinson State Park, Nebraska in the spring of 2006.

Plant species	Ewe	Lamb
sedges	24%	-
fringed sagebrush	15%	-
needleandthread	15%	-
grama/dropseed type	10%	-

Summer. - The 2006 summer bite counts showed that the forbs were the primary forage, followed by browse and graminoids in the ewe's diet (20 bite counts). The important forbs in the diet were sweetclover (*Melilotus spp*. P. Mill), Russian thistle (*Salsola iberica* Senn. & Pau.) and gayfeather (*Liatris punctata* Hook.). While chokecherry (*Prunus virginiana* L.), yucca and prairie sandreed (*Calamovilfa longifolia* (Hook.) Scribn.) were the two browse and only graminoid respectively. The 2007 summer season bite counts revealed that forbs were the only

forage in the ewe's diet (11 bite counts). The important forbs in their diet were white aster (*Aster ericoides* L.), prostrate knotweed (*Polygonum aviculare* L.), milkvetch (*Astragalus spp*. L.) and hairy goldaster (*Chrysopsis villosa* (Pursh) Nutt.) (Table 15 & 16).

The 2006 (8 bite counts) and 2007 (11 bite counts) summer bite counts also showed that forbs dominated the lambs diet, followed by graminoids. The important forbs in the lambs diet were sweetclover, white aster, prostrate knotweed, alfalfa, fleabane (*Erigeron spp. L.*), and white prairieclover (*Dalea candida* Michx. ex Willd.) (Table 15 & 16). Prairie sandreed was the only graminoid in the lamb's diet.

Table 15. Bighorn sheep bite counts at Fort Robinson State Park, Nebraska in the summer of 2006.

Plant Name	Ewe	Lamb
sweetclover	17%	50%
chokecherry	14%	-
yucca	14%	-
Russian thistle	11%	-
gayfeather	9%	-
prostrate knotweed	7%	17%
white aster	5%	24%
prairie sandreed	2%	7%

Table 16. Bighorn sheep bite counts at Fort Robinson State Park, Nebraska in the summer 2007.

Plant Name	Ewe	Lamb
white aster	28%	38%
yucca	24%	11%
prostrate knotweed	13%	-
hairy goldaster	10%	-
milkvetch	8%	-
alfalfa	-	14%
fleabane	-	13%
prairieclover	-	8%

In contrast to both the 2006 and 2007 bite counts, the 2006 summer microhistiological samples (45 ewe and 25 lamb samples) were similar between the ewes and lambs. This may have been due to the fact there were more samples for comparison. Both diets were dominated by graminoids again, mainly grama/dropseed grasses, followed by forbs (Table 17). The other

important graminoids were sedges, needleandthread and Junegrass, while the forbs were cudweed sagewort and western ragweed.

Table 17. Bighorn sheep microhistiological results at Fort Robinson State Park, Nebraska in the summer of 2006.

Plant species	Ewe	Lamb
grama/dropseed type	32%	35%
needleandthread	12%	8%
sedges	8%	8%
Junegrass	6%	6%
western ragweed	6%	7%
cudweed sagewort	1%	6%

Fall. - The fall diets again found graminoids dominating both the ewe and lamb diets for 2006 (16 ewe and 10 lambs samples) and 2007 (10 ewe and 10 lamb samples), followed by forbs and then browse. The important graminoids in the diets were downy brome, Junegrass, Kentucky bluegrass (*Poa pratensis* L.), wheatgrass, blackroot, sun sedge (*Carex spp.* L.) and winter wheat (*Triticum aestivum* L.). The important forbs were phlox, white aster, whorled milkweed (*Asclepias verticillata* L.), goldenrod, and hairy goldaster. The only browse was chokecherry (Table 18 & 19).

Table 18. Bighorn sheep bite counts at Fort Robinson State Park, Nebraska in the fall of 2006.

Plant Name	Ewe	Lamb
downy brome	34%	37%
white aster	20%	25%
whorled milkweed	18%	-
phlox	10%	-
chokecherry	8%	-
wheatgrass spp.	1%	10%
Junegrass	-	10%
Kentucky bluegrass	-	16%

Table 19. Bighorn sheep bite counts at Fort Robinson State Park, Nebraska in the fall of 2007.

Plant Name	Ewe	Lamb
blackroot	23%	25%
wheatgrass spp.	23%	10%
white aster	14%	18%
winter wheat	13%	14%
goldenrod spp.	9%	-
hairy goldaster	7%	15%
sun sedge	-	10%

The 2006 fall microhistiological samples (50 ewe and 43 lamb samples) were similar to the 2006 and 2007 bite counts; dominated by graminoids with forbs second, followed by browse (Table 20). The primary graminoid forage for both ewes and lambs was needleandthread, followed by sedges and grama/dropseed grasses. The forbs were cudweed sagewort, and hairy goldaster, while the browse were yucca and fringed sagebrush.

Table 20. Bighorn sheep microhistiological results at Fort Robinson State Park, Nebraska in the fall of 2006.

Plant species	Ewe	Lamb
needleandthread	26%	22%
cudweed sagewort	18%	15%
sedges	10%	10%
grama/dropseed type	9%	12%
yucca	6%	5%
fringed sagebrush	5%	6%
hairy goldaster	3%	5%

Winter. - Graminoids continued to dominate the ewes and lambs bite count diets for 2006 (8 ewe and 10 lamb samples) and 2007 (5 ewe and 7 lamb samples) winters, followed by forbs and browse, which were about equal in importance. The important graminoids in the diet were downy brome, wheatgrass, needleandthread and blackroot sedge. Phlox was the important forb, while fringed sagebrush was the important browse (Table 21 & 22).

Table 21. Bighorn sheep bite counts at Fort Robinson State Park, Nebraska in the winter of 2006.

Plant Name	Ewe	Lamb
downy brome	78%	70%
phlox	14%	18%
wheatgrass spp.	8%	3%
shelleaf penstemen	-	7%

Table 22. Bighorn sheep bite counts at Fort Robinson State Park, Nebraska in the winter of 2007.

Plant Name	Ewe	Lamb
blackroot	60%	75%
fringed sagebrush	30%	15%
wheatgrass spp.	8%	5%
needleandthread	2%	5%

The 2006 winter microhistiological samples (23 ewes, 16 lambs) were similar between the ewes and lamb's diet. Unlike the 2006 and 2007 bite counts, the diet was dominated by forbs, with the most important forb was being cudweed sagewort (Table 23). Following the forbs were both graminoids and browse equally. The important graminoids were needleandthread and bluegrass, while the only browse was fringed sagebrush.

Table 23. Bighorn sheep microhistiological results at Fort Robinson State Park, Nebraska in the winter of 2006.

Plant species	Ewe	Lamb
cudweed sagewort	39%	30%
needleandthread	12%	13%
fringed sagebrush	9%	14%
yucca	8%	14%
bluegrass type	6%	6%
sedges	4%	6%

Overall data. - Seasonal data was combined to represent a yearly bite count diet. Both 2006 and 2007 yearly bite count diets demonstrated that graminoids were the primary forage of both the ewes and lambs diet, while forbs were second. The important graminoids for the yearly bite count diet were downy brome, wheatgrass, and blackroot. The important forbs of the bite count diet were sweetclover, white aster and hairy goldaster (Table 24 and 25). The total number of ewe bite counts were 57 (2006) and 29 (2007). The total number of lamb bite counts were 29 (2006) and 28 (2007).

Table 24. Yearly bighorn sheep bite counts at Fort Robinson State Park, Nebraska in 2006.

Plant Name	Ewe	Lamb
downy brome	24%	42%
wheatgrass spp.	12%	5%
blackroot	9%	5%
white aster	7%	11%
sun sedge	6%	7%
sweetclover	5%	10%
Kentucky bluegrass	-	6%

Table 25. Yearly bighorn sheep bite counts at Fort Robinson State Park, Nebraska in 2007.

Plant Name	Ewe	Lamb
blackroot	18%	33%
white aster	14%	18%
yucca	10%	3%
wheatgrass spp.	9%	6%
hairy goldaster	7%	6%
winter wheat	4%	6%

The 2006 microhistiological sample results were combined for both the ewes and the lambs to give a yearly diet representation. The 2006 yearly microhistiological sample (128 ewe and 84 lamb samples) analysis for the ewe and lamb diets were similar to the data from the bite count data (Table 26). Like the 2006 and 2007 bite counts, diets were heavily dominated by graminoids according to microhistiology. The important graminoids, which is different than the 2006 and 2007 bite counts, consisted of needleandthread, grama/dropseed grasses, and sedges. Forbs were second in diet selection, with cudweed sagewort being the most important forb. Browse was third in diet selection with fringed sagebrush being the most important followed by yucca.

Table 26. Yearly bighorn sheep microhistiological results at Fort Robinson State Park, Nebraska in 2006.

Plant species	Ewe	Lamb
needleandthread	17%	16%
grama/dropseed type	16%	17%
cudweed sagewort	15%	15%
sedges	9%	9%
fringed sagebrush	6%	7%
yucca	5%	6%

Diet Competiton

No data was collected to determine if any diet competition occurred. There were six observations of spatial overlap between bighorn sheep and livestock (domestic sheep, cattle, bison, donkeys, and horses). All encounters resulted in the bighorn sheep being displaced by the livestock. Four of the incidents were at a stock tank and three were on slopes. Four of the encounters occurred with horses, while one encounter was with cattle and the last situation was with domestic bison. No direct competition was observed between wildlife (deer, elk, pronghorn) and the bighorn sheep.

Three of the horse observations were around stock tanks and in each encounter the horses would not allow the sheep near the water until they were done. The other incident with the horses was witnessed while a group of bighorn sheep were foraging steadily up a slope. The bighorn sheep kept a minimum distance of roughly 60 meters between them and the horses while steadily moving further up slope and away from the horses. The horses never approached or made actions towards the group of sheep.

The only cattle observation occurred at a stock tank where the sheep drank along side the longhorns until too many longhorns came to the stock tank resulting in bighorn sheep leaving the area. The only bison observation resulted with the bighorn sheep giving ground as the foraging bison moved slowly up the slope to the bighorn sheep foraging at the base of the butte rock. As the bison came closer the sheep slowly would move up or away from the bison.

DISCUSSION

The diet results indicated that graminoids were the dominate forage in the Fort Robinson herd's diet, which agrees with the dietary literature for Rocky Mountain bighorn sheep (Blood

1967, Oldemeyer et al. 1971, Brown and Yde 1988, Goodson et al. 1991a & 1991b, Nordeen 2007). The most important graminoids found in the micohistiological sample diet were sedges, needleandthread, grama/dropseed grasses, and Junegrass. The most important forbs were western ragweed, cudweed sagewort, and hairy goldaster. The two browse specie that was dominant in the micohistiological was fringed sagebrush and yucca. This study suggests that the Fort Robinson bighorn sheep herd's diet is dominated by graminoids during the spring, summer, fall and on a yearly bases, which is supported by Todd (1975), Brown and Yde (1988), and Nordeen (2007). The winter season bite count and microhistiological diets contradicted each other. This was probably due to the inconsistent number of bite count observations throughout the study and biases by the observer. One error noticed during bite count observations was the inability to identify the plant under grazing pressure in an open grassland area. Bite count observations were more difficult to gather than micohistiological samples because of weather, difficulty with identifying the plant species under grazing, difficulty in collecting observations from various areas of grazing, and collecting the targeted number of observations each month. Due to these encumbrances, the bite count results were not as strong or as reliable as they could have been. Unfortunately there was only enough time and money to get results for the micohistiological samples from 2006, thus the micohistiological samples could not be used for a comparison with the bite count for the entire study.

The plant species that were selected for by the Fort Robinson herd were frequent within the heavily used areas (Saddle Rock, Smiley Canyon and Mexican Canyon). The Saddle Rock area contained needleandthread (30-63%), sedges (60-80%), grama/dropseed (13-45%), and fringed sagebrush (29-50%), while cudweed sagewort and western ragweed were not frequent. Mexican Canyon contained needleandthread (26-45%), sedges (12-48%), grama/dropseed (30%

or less), fringed sagebrush (19-28%), while cudweed sagewort and western ragweed were found (14-37%). While in the Smiley Canyon area there was needleandthread (0-58%), sedges (14-58%), grama/dropseed between (13-15%), fringed sagebrush (15-36%), and western ragweed (16-30%), while cudweed sagewort was not frequent. The occurrence of the dominant plant species from the diet being frequent in the areas that were heavily used by the bighorn sheep indicates that the sheep could be selecting these areas based on forage availability.

During this study, the direct competition between livestock and the bighorn sheep tended to be around water (stock tanks) and salt licks. In every incident the ewes and lambs gave ground to cattle, horses and bison. The majority of the incidents occurred in July and August when the sheep were moving to the stock tanks on a daily bases for water. This direct competition did not inhibit the bighorn sheep from getting water or salt, because after the livestock were done the sheep were allowed to get water or salt. Typically anytime bighorn sheep encountered livestock of any kind, the sheep would give ground in a direction towards escape cover.

MANAGEMENT IMPLICATIOINS

It is recommended that microhistiological analysis be the only means for collecting dietary data for wildlife. Bite count observations are difficult to conduct through a spotting scope and create too much bias. These observations are extremely time-consuming, plus the end results are not as reliable as the microhistiological analysis.

One management delema with this herd is going to be the indirect forage competition with livestock and/or wildlife, which is suggested through the literature. It is recommended that a study be conducted to identify how much indirect forage competition occurs and with what species of ungulate. Along with this study it is recommended that an evaluation of fences/fence

conditions and how pasture rotation effects the bighorn sheep. If these management issues is not addressed or improved, then this bighorn sheep herd could potentially face disease epidemics, nutritional problems, and/or habitat constraints.

It is also suggested to increase plant diversity through prescribed fires. The prescribed fires should be burned in the spring and fall seasons. This should encourage warm season species to become more prominent and also promote forbs. Broadcast seeding overtop the burns is not recommended because it increases the expense of the project and the results can be to variable to justify doing.

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FORT ROBINSON BIGHORN SHEEP'S HOME RANGE ON THE PINE RIDGE REGION OF NORTHWEST NEBRASKA

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Abstract: This study was conducted in 2006 and 2007 to determine the home range for the Fort Robinson bighorn sheep (*Ovis canadensis*) herd located near Crawford, Nebraska. The herd's population had gone through a decline and was struggling to recover, thus this study could help narrow the causative agent or agents responsible for this. The objectives of this study were to quantify the locations inhabited by bighorn sheep during the seasons and quantify the travel paths between home ranges by bighorn sheep. Sheep locations were collected in latitude and longitude with a Garmin Rhino (model 130). The locations were then entered into the GIS to create shape files so home ranges could be created using the adaptive and fixed kernel method and the minimum convex polygon method. There was a significant difference between the fixed and adaptive kernel models based on both years of the data. There was a significant difference between the first year and second year's data for the fixed kernel model, but there was no significant difference for the adaptive kernel model. The two dimensional surface areas from the models were created in three dimensions for comparison. There was a significant difference between the 2D and 3D surface areas for both the 95% adaptive and 95% fixed kernel methods using both years of the data. There was a significant difference between the 2D and 3D surface areas for the 95% fixed kernel method comparing year one and year two, but there was no significant difference for the 95% adaptive kernel method between year one and year two. The Fort Robinson bighorn sheep ewe's home range size was determined to be 50.1 km² based on the adaptive kernel model. The home range sizes were also produced in the minimum convex polygon method for comparison with older studies and data. The minimum convex polygon method was not used because the home range sizes were significantly smaller than the kernel methods and it included more area that was not utilized by the big horn sheep.

Key words: Rocky Mountain bighorn sheep, *Ovis canadensis*, home range

INTRODUCTION [4]

In 1981 the Nebraska Game and Parks Commission reintroduced six Rocky Mountain bighorn sheep into a 202-ha enclosure at Fort Robinson State Park near Crawford Nebraska (Fairbanks 1985). The goal of this reintroduction was to reestablish bighorn sheep into their native range because they were extirpated from Nebraska by about 1890 (Grier 1989). The original plan was to create a parent population by expanding the herd to 25 individuals. The parent population would be maintained in the enclosure with additional individuals being released to establish a wild population (Fairbanks 1985). Twenty-one bighorn sheep were released from the enclosure in 1988 with the remaining 23 being released in 1993 when the enclosure was removed. The Nebraska Game and Parks Commission has maintained the Fort Robinson bighorn sheep herd as a free ranging, wild herd, only intervening to add new genetics

4 Format follows: Journal of Wildlife Management

from other populations since then. Hunting was added as a management tool in 1998 with no more than two tags having been issued in any given year.

Since the removal of the enclosure, the population slowly increased to just over a hundred individuals in 2003. Contagious ecthyma was confirmed in 2004, killing some lambs. Then for unknown reasons the herd numbers plummeted to around fifty individuals by the summer of 2005. From January to June of 2005, Nebraska Game and Parks Commission staff gathered thirteen bighorn sheep skulls, representing of both sexes, from Fort Robinson State Park. The 2005 lamb crop resulted in sixteen verified births from 22 adult ewes, but by November there were only four lambs alive. No lamb carcasses were discovered during the summer to determine the cause of the reduced numbers.

Previous research conducted at Fort Robinson evaluated habitat for bighorn sheep in the Pine Ridge (Forbes and Merchant 1998), sex-specific habitat selection by low elevation bighorn sheep (Klinksiek 2004), and lambing sites for the bighorn sheep in the Pine Ridge (Powers 2006). The goals of this study were to determine the causative agent or agents, which may be resulting in the Fort Robinson's population declines. Thus this study focused on studying the herd's home range to understand the movement habits and the areas this herd uses. With this information certain agents, such as contact with livestock, could be investigated further or ruled out as a possible agent or agents for the populations decline. The specific study objectives will be:

(1) Establish home range and migration patterns of the Fort Robinson bighorn sheep herd,

- Quantify the locations inhabited by bighorn sheep during the seasons
- Quantify travel paths between home ranges by bighorn sheep

LITERATURE REVIEW

Home Range

Home range is the area to which an animal confines itself for its day-to-day activities (Calhoun 1963). Giest (1971) agrees with Houston (1968) that this definition does not apply to mountain sheep. Mountain sheep may occupy as high as six or seven different home ranges, which tend to follow a seasonal pattern, but few sheep have two seasonal home ranges (Giest 1971). Giest (1971) says that the distance between home ranges can be anywhere from one-half mile to twenty miles or more, with the home ranges usually separated by at least one deep gorge. Traditionally bighorn sheep home ranges can be very large, averaging nearly 15 square kilometers (Bighorn Sheep Facts 2002, Nordeen 2007). One thing to understand is that a home range is a measure of an animal's habitat and not a well-defined area with rigid boundaries though they are usually portrayed as such (Giest 1971).

Research has found that many herds have lost traditional migration patterns and have become sedentary (Bear and Jones 1973, Goodson 1980, Wakelyn 1984, Risenhoover and Bailey 1985) and many transplanted herds have failed to expand geographically (Geist 1971, Goodson 1980, Risenhoover and Bailey 1985). Sedentariness has also been suggested as a reason for bighorn sheep becoming infected with lungworm-induced pneumonia (Hibler 1974, Bailey 1980, Wishart 1985, Risenhoover and Bailey 1985). This could account or partially account for the Fort Robinson bighorn sheep herds struggle to keep a stable population.

According to Getz et al. (2007), parametric kernel methods are currently dominating the literature on animal home ranges and utilization distributions. Currently it is accepted that 95% of the innermost data is represented in an isopleth (boundary line), however Borger et al.'s (2006) study suggests that using isopleths at a 50-90% range reduce bias by sample size. The

reasons for omitting outlying points in estimating home ranges are: inaccuracies of locations by triangulation of radio collars, home range models of parametric kernel methods and minimum convex polygon method are sensitive to outlying points, and outlying points may well reflect exploratory movements more than actual home ranges (Getz et al. 2007). Getz et al. (2007) also found that using a new local convex hull nonparametric kernel method (that generalizes the minimum convex polygon method) was more appropriate in constructing home ranges and utilization distributions than parametric kernel methods. The nonparametric kernel method reduces the bias of the investigator by relieving the burden of the investigator from choosing a functional form for the kernels. The nonparametric kernel method takes the functional form directly from the data. The nonparametric method makes a small error, which is locally approximating the actual boundary by fitting a line between the two points closest to the true boundary element in question.

Kernohan et al. (1998) studied the benefits of the adaptive kernel method for estimating home ranges. The adaptive kernel method represented habitat use accurately. The adaptive kernel method frees the parametric assumptions and provides a means of smoothing locational data, which is preferred over other home range estimators such as the minimum convex polygon (MCP) or the bivariate normal (Worton 1989).

Worton (1989) studied the differences between the fixed and adaptive kernel method with different smoothing parameters for each method. His results showed that the adaptive kernel method with least-squares cross-validation (smoothing parameter) produced the best results overall, though the fixed kernel method with an ad hoc smoothing parameter produced practical values as well. Worton (1989) recommends that if accuracy is not crucial, that the fixed kernel method with an ad hoc parameter will provide the information needed, but if accuracy is a must,

such as static attraction/repulsion, then the adaptive method with least-squares cross-validation parameter should be used. This study shows that kernel methods are beneficial for estimating utilization distribution densities because the method does not place constraints on the form of the utilization distribution.

In contradiction to Worton (1989), Seaman and Powell (1996) found that the fixed kernel performed better than the adaptive kernel on all of the tests, but these two models have not been thoroughly explored by statisticians and have not been applied to real data. The fixed kernel with least-squares cross-validation gave surface area estimates with the lowest errors. Their results also indicated that using an adaptive kernel method typically overestimated the surface of distribution, which resulted in a high error with surface estimations. According to Swihart and Slade (1997) there are three factors that cause problems for estimation procedures: the distribution is two-dimensional, distributions rarely conform to parametric models, and observations of individual animals are not always independent from each other. Seaman and Powell's (1996) results also indicated that the kernel methods from small samples would overestimate home range size and poorly demonstrate fine structures, such as an impassible cliff face.

Seaman et al. (1999) studied the effects of sample size on kernel home range estimates. All home range or utilization distributions are subject to sampling error, which is over come by increasing sample size. Certain studies have shown that 100 to 300 locations are needed to produce accurate home ranges with the MCP method (Bekoff and Mech 1984, Laundre and Keller 1984, Harris et al. 1990). Seaman et al. (1999) suggest that home range studies that use kernel methods should obtain at least 30 locations, but more than 50 locations are preferred. If authors report sample size and exact home range estimation methods used, which can aid in

developing and perfecting the kernel methods so it can replace the commonly used MCP method, which has widespread recognition of its weaknesses (Seaman et al. 1999).

Stone et al. (1997) explored the use of geographical information systems (GIS) to more clearly and accurately represent an individual's home range because traditional planimetric home ranges do not account for differences in topography. Changes in topography increases surface area, thus home range sizes are inaccurately represented if topography is not accounted for. This study showed (by digitizing topographical images with Triangulated Irregular Networks (TINs) three-dimensional mapping program in ARC/INFO (Stone et al. 1997)) that topographic estimates were significantly larger than planimetric estimates.

In accordance with Stone et al. (1997), Jenness (2004) studied methods used to calculate surface area from digital elevation models (DEMs). The knowledge of the true surface area of a landscape is very important in representing an accurate home range size and it is found that surface area represents a better estimate of land area than planimetric areas. By using Geographical Information Systems (GIS) and DEMs, surface areas can be accurately generated, though this method is slightly less accurate than TINs (Jenness 2004).

Zimmerman (2008) studied the home-range and habitat selection of translocated and resident bighorn sheep at Badlands National Park in South Dakota. Zimmerman (2008) used the non parametric adaptive and fixed kernel estimator with the *ad hoc* bandwidth to represent the home ranges of the translocated and resident bighorn sheep. The surface areas were calculated in two dimensional (2D) and three dimensional (3D) surface areas. The 3D surface areas were calculated from digital elevation models with the 3D analyst tool in ArcGIS 9.2. The contours from the digital elevation model were used to create triangulated irregular networks (TINs). The adaptive and fixed kernel home-ranges were displayed in 95% and 50% isopleths. Wilcoxon

signed rank tests were used to compare the 95% and 50% adaptive kernel estimates to the fixed kernel estimates, interannual home-range size, and the planimetric to surface area home-range size. Zimmerman's (2008) results indicated that the 3D surface areas were larger than 2D surface areas, which suggests the area required by bighorn sheep is larger than previously expected. There was no difference between the 95% adaptive kernel home-range and the fixed kernel home-range. There was also no difference between the 95% adaptive kernel home-range and the 95% minimum convex polygons (MCP), though the MCP included lands not known to be used by the bighorn sheep. The 95% adaptive kernel home-ranges for the resident sheep were greater than the translocated sheep home-range.

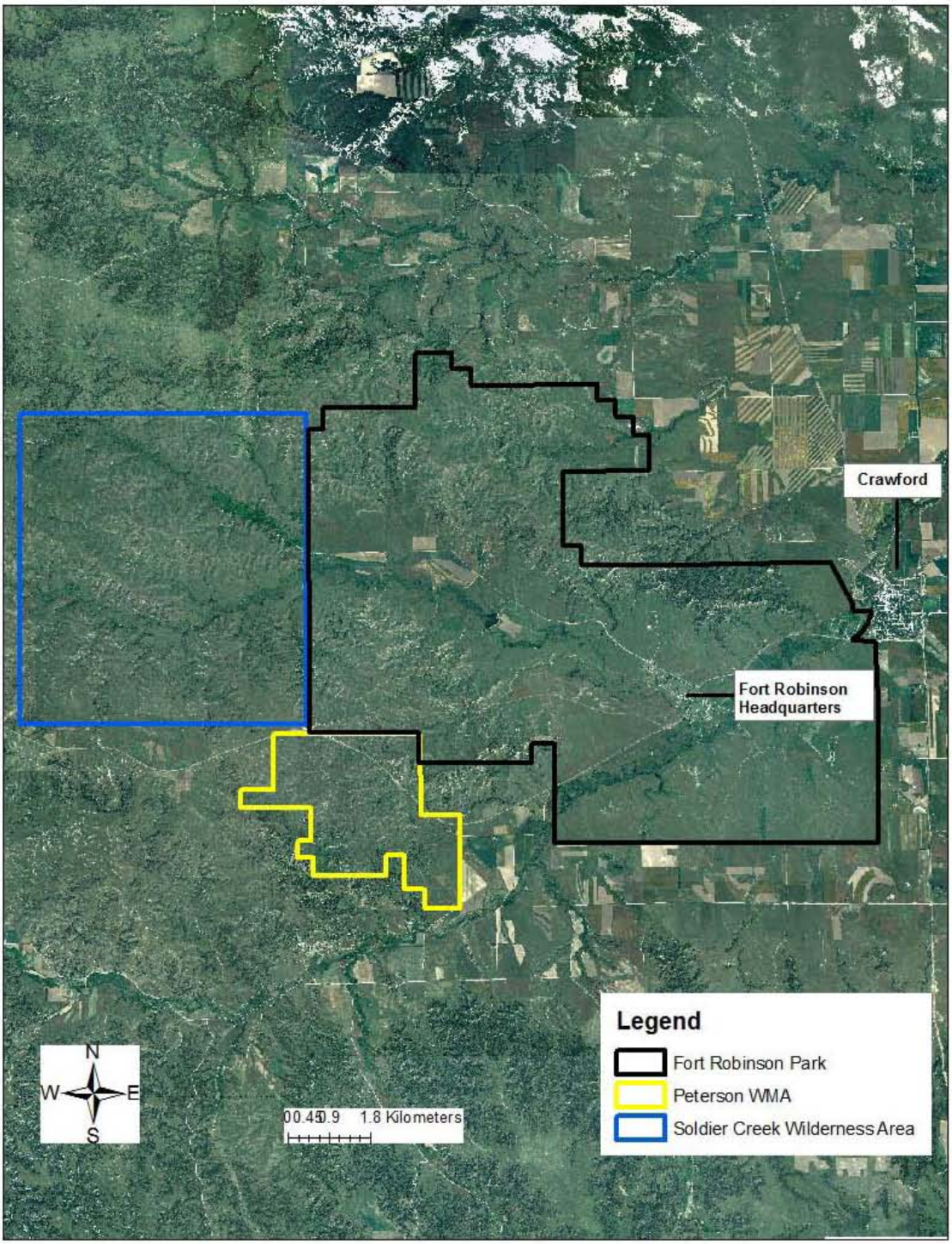
METHODS

Study Area

The location of this study was Fort Robinson State Park (42°39'59.9", 103°27'55.9"), located approximately 4.8 kilometers west of Crawford, Nebraska, in Sioux and Dawes Counties. The study area lies within the Pine Ridge escarpment in the Northwest part of the Nebraska panhandle. Fort Robinson State Park has roughly 16,322 ha, which varies in topography from gently rolling hills to rugged buttes that range in elevation from 1,132m to 1,491m (Fairbanks 1985, Klinksiek 2004). The study area also included Soldier Creek Wilderness Area (42°41'47.6", 103°34'08.8") which boarders Fort Robinson on the west, Peterson Wildlife Management Area (42°38'33.5", 103°31'51.0") adjacent to the south and private lands adjacent to the Fort (Figure 5).

The climate near the area is typically warm in the summers with periods of very cold weather in the winters. The average temperature for summer and winter is 19°C and -4°C respectively. The hottest recorded temperature was 40°C and the coldest was

Figure 5. The boundaries of the study area at Fort Robinson State Park, Crawford Nebraska, USA.



-36°C. The annual precipitation for the area is around 44 cm. The heaviest precipitation generally falls between March and June. Snowfall is usually frequent throughout the winter, with the snow cover dissipating during mild periods. All weather records were taken from the weather station in Harrison, Nebraska, located roughly 48 km west of Crawford (High Plains Regional Climate Center 2007).

The Fort Robinson area is considered an open grassland savanna dominated by blue grama (*Bouteloua gracilis* (H.B.K.) Lag. *ex* Griffiths) [5], little bluestem *(Schizachyrium scoparium* Michx.), western wheatgrass (*Agropyron smithii* Rydb.), needleandthread grass (*Stipa comata* Trin. & Rupr.), blackroot sedge (*Carex filifolia* Nutt.), sand bluestem (*Andropogon hallii* Hack.), sideoats grama (*Bouteloua curtipendula* (Michx.) Torr.), bluegrass (*Poa spp*. L.), green needlegrass (*Stipa viridula* Trin.), prairie sandreed (*Calamovilfa longifolia* (Hook.) Scribn.), western snowberry (*Symphoricarpos occidentalis* Hook.), skunkbrush sumac (*Rhus aromatica* Ait.), chokecherry (*Prunus virginiana* L.), and ponderosa pine (*Pinus ponderosa* Laws). The most prominent soils for Fort Robinson are Tassel-Ponderosa-Rock outcrop association and Ponderosa-Tassel-Vetal complex (United States Department of Agriculture 1977).

Capture

Radio telemetry was the primary means of locating marked individuals, which was any individual with a telemetry collar and ear tag, for field observations. In July 2006, there were twelve ewes marked with ear tags and radio collars, however only five of the collars were working consistently. Therefore, in January 2007, Quicksilver Aviation Inc. was hired to capture twenty-four individuals (19 ewes, 5 rams) to have new collars and ear tags put on. Each sheep was net gunned via helicopter, once captured they were blindfolded and hobbled to ensure the

5 Nomenclature follows: Flora of the Great Plains (McGregor et al. 1986)

sheep's and biologist's safety. Then they were transported to the eastern fence line of the park, where biological samples were taken by wildlife biologists.

Once the sheep were in the hands of the biologist, a thermometer was inserted rectally to monitor the sheep's temperature. If the temperature went above 41°C, water and rubbing alcohol were rubbed on the abdomen to cool the animal. If the temperature reached 42°C to 43°C, there was a good chance the sheep could succumb to capture myopathy. If a sheep's temperature was not brought down below 41°C, no samples were taken and the sheep were released as quickly as possible. If any of the sheep had an old collar and ear tag, it was replaced with a new one. The samples taken from each individual were fecal, hair, ear notch, blood and hoof. The fecal samples were for testing of lungworm concentrations in the herd. The ear notch was taken along with hair (from above the tail and between the hooves) for DNA records. Blood was drawn to test for Epizootic Hemorrhagic Disease and a piece of hoof was removed for base line data on mineral content, which could be compared against samples from sheep with deformed hooves (Nordeen 2007).

Home Range

As many field observations were conducted as possible for two full calendar years. During field observations the following information was recorded: sex/age classifications, habitat occupied; activity; Global Positioning System (GPS) location; weather conditions (cloud cover, temperature, wind speed, wind direction, relative humidity); aspect; time of day; and distance from water, escape habitat, livestock, and people. Sheep locations were recorded in latitude and longitude with a GPS unit. If the exact location could not be plotted, because the sheep never moved off the area, the observers location was recorded in latitude and longitude along with the distance in meters to the actual location (using a range finder), and direction in

degrees to the actual location using a compass. Exact sheep locations were determined later by using trigonometry. GPS locations were gathered with a Garmin Rhino (Model 130), weather conditions were gathered with a pocket weather meter (Kesterl 3000), and the distance/direction were gathered using a Leupold Wind-River range finder (Model RB 800C).

The GPS locations were entered into ESRI ArcGIS 9.3, a Geographical Information System (GIS) software package, to make a visual representation of the distribution and movements of the various individuals. Home-Range Tools Analysis Extensions was downloaded for ArcGIS to create 95% and 50% isopleth contours using non-parametric fixed kernel and adaptive kernel estimators with the *ad hoc* bandwith (Brundige 1985, Worton 1989, Stone et al. 1997, Kernohan et al. 1998, Seaman et al. 1999, Zimmerman 2008). The home range models were ran on all data collected from the seventeen collared ewes, but the Wilcox signed rank test (Zimmerman 2008) was only conducted on only the data from the ten ewes, whose data covered the full two years of the study. The locations were split from March 2006 to February 2007 for year one data, while locations from March 2007 to February 2008 were considered year two data. The home ranges surface areas were then compared, using a paired t-test, in 2-dimensional (aerial photographs) and 3-dimensional (digital elevation models) surface areas (Jenness 2004). Home ranges were also created using the minimum convex polygon method (MCP) for comparison with older studies and data sets. All home range data are reported in Appendix 8A.

RESULTS

Seasonal Use

There were small movement patterns and migrations within the adult ewe's home range that centered around Red Cloud Buttes, Mexican Canyon, School Section (all three lie north and northeast of Fort Robinson State Park headquarters) and Smiley Canyon areas (lies southwest of

Fort Robinson State Park headquarters) (Figure 6). During the spring seasons (March, April, and May) the ewes primarily used the exposed Red Cloud Buttes, Sheep Trap Canyon, Mexican Canyon areas, but there was also a little use of the Smiley Canyon area (Figures 7 & 8). The movements during the spring 2007 were slightly different because the ewes moved farther and more frequent after the capture operation that ended in February 2007.

During the late spring and early summer (May and June) the ewes move to various places to lamb. A majority of the lamb sites occurred on Red Cloud Buttes and Smiley Canyon, though a few ewes moved to Jack Kreman's property (Figure 9), which was south of Peterson WMA, to lamb. They spent between one to three weeks before they came back to the public property. There were also two individuals that went to Five Points (Figure 9), northwest of the Soldier Creek Wilderness area, to lamb. Both Jack Kreman's property and Five Points were privately owned and no access was allowed, thus no locations could be gathered in these areas.

The summer seasons (June, July, and August) the ewes split their use rather evenly between the Red Cloud Buttes/Mexican Canyon area and Smiley Canyon (Figures 10 & 11). Smiley Canyon was where the nursery groups would congregate as the lambing season came to an end, about the beginning of July. Then by August the ewes would start moving back to the Red Cloud buttes/Mexican Canyon area.

The fall seasons (September, October, and November) found the ewes concentrated in the School Section and Mexican Canyon areas. There were some ewes that moved back and forth between Mexican Canyon and Smiley Canyon areas (Figures 12 & 13). There was only one travel corridor used between the areas (Figure 14).

Figure 6. The areas used during the 2006 and 2007 study at Fort Robinson State Park, Crawford Nebraska, USA.

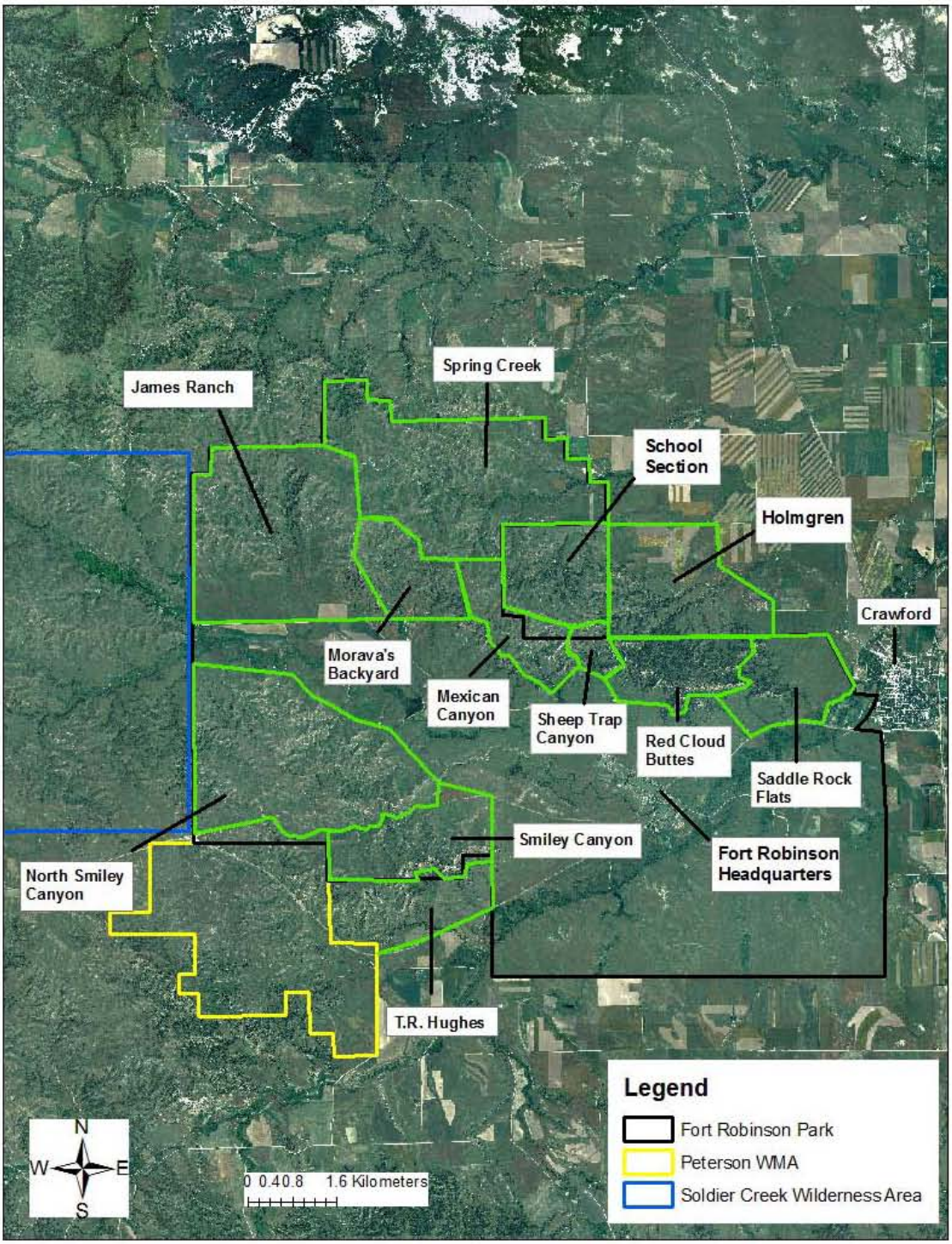


Figure 7. The 2006 ewe locations from the spring season at Fort Robinson State Park, Crawford Nebraska, USA.

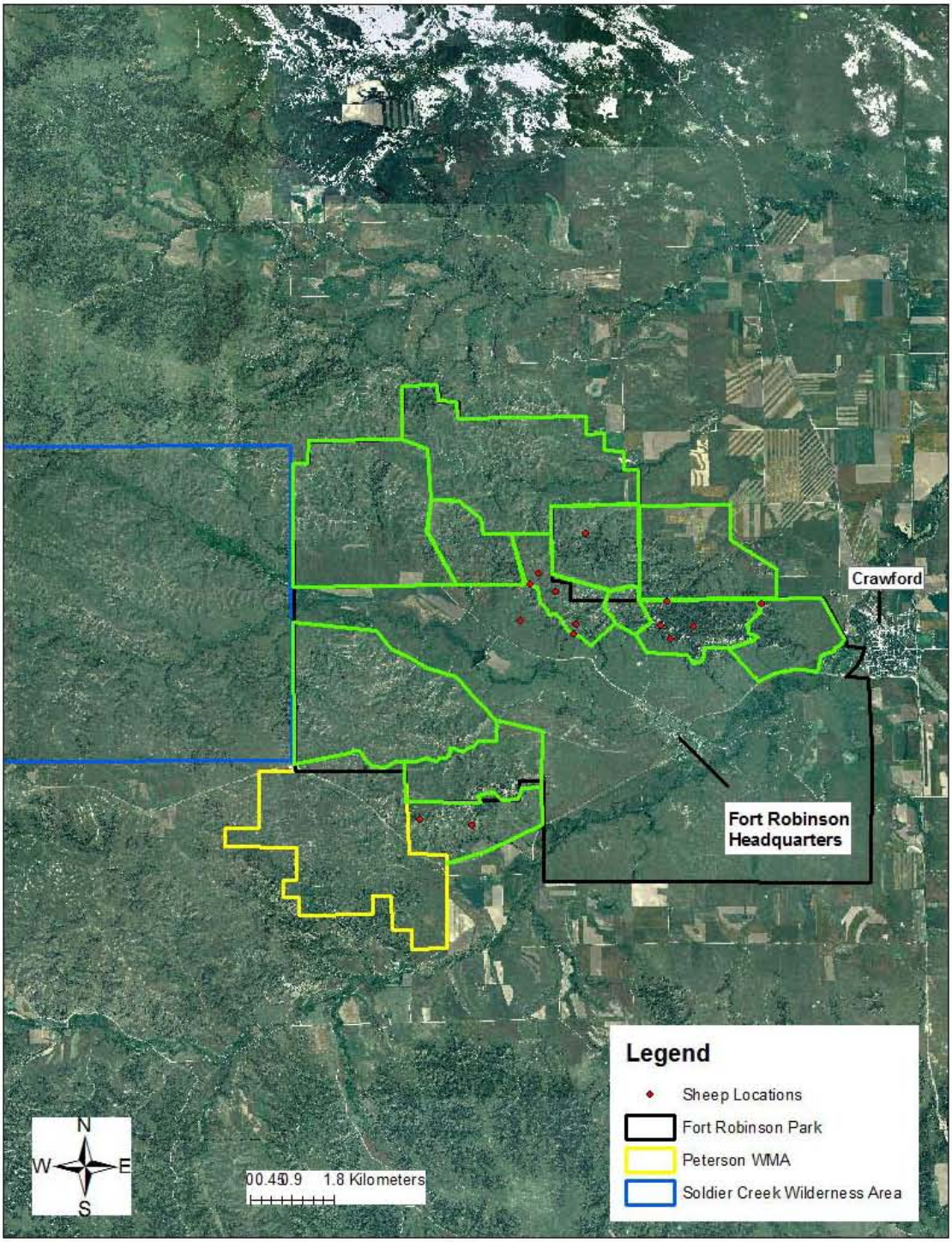


Figure 8. The 2007 ewe locations from the spring season at Fort Robinson State Park, Crawford Nebraska, USA.

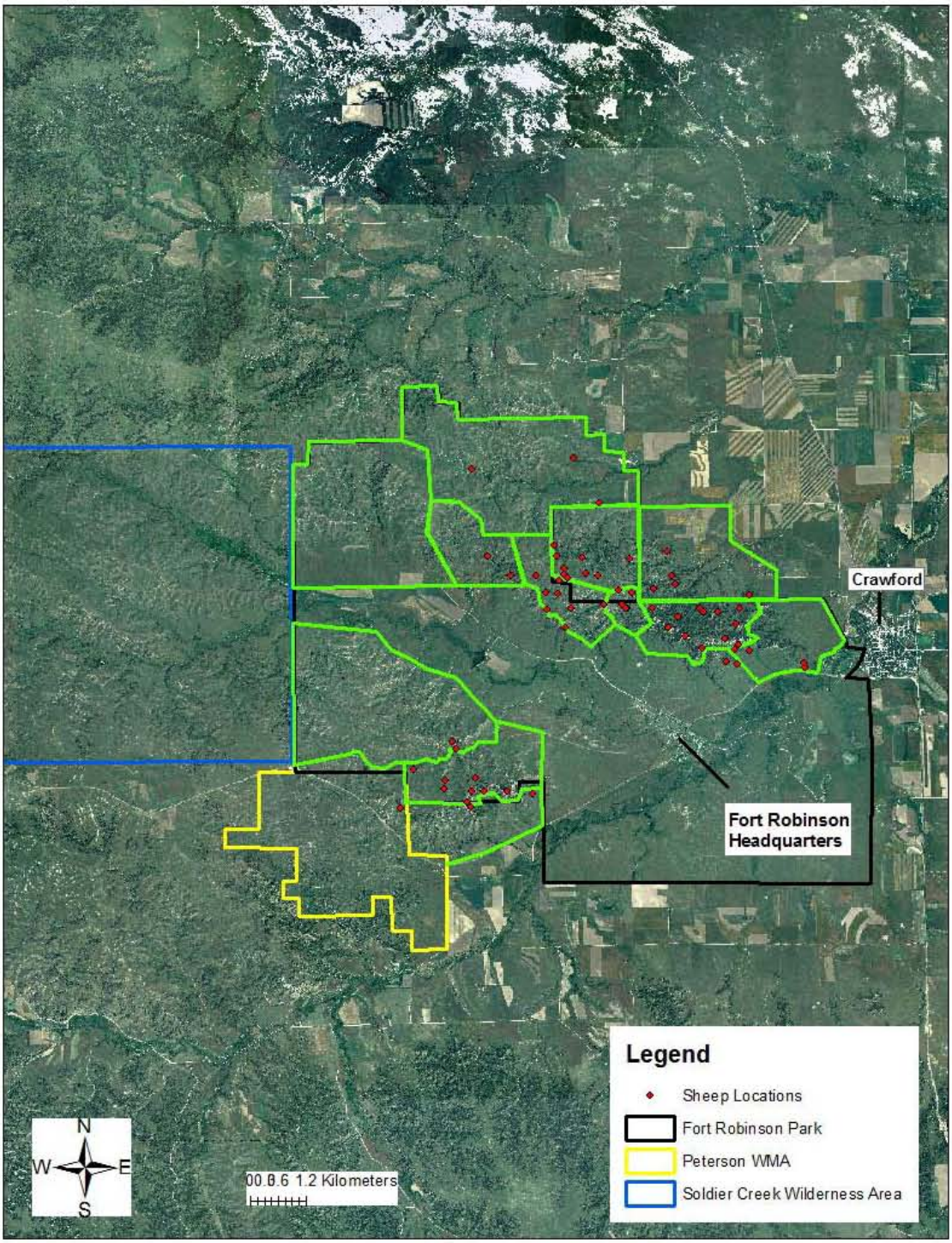


Figure 9. The private property areas used for lambing season during the 2006 and 2007 study at Fort Robinson State Park, Crawford Nebraska, USA.

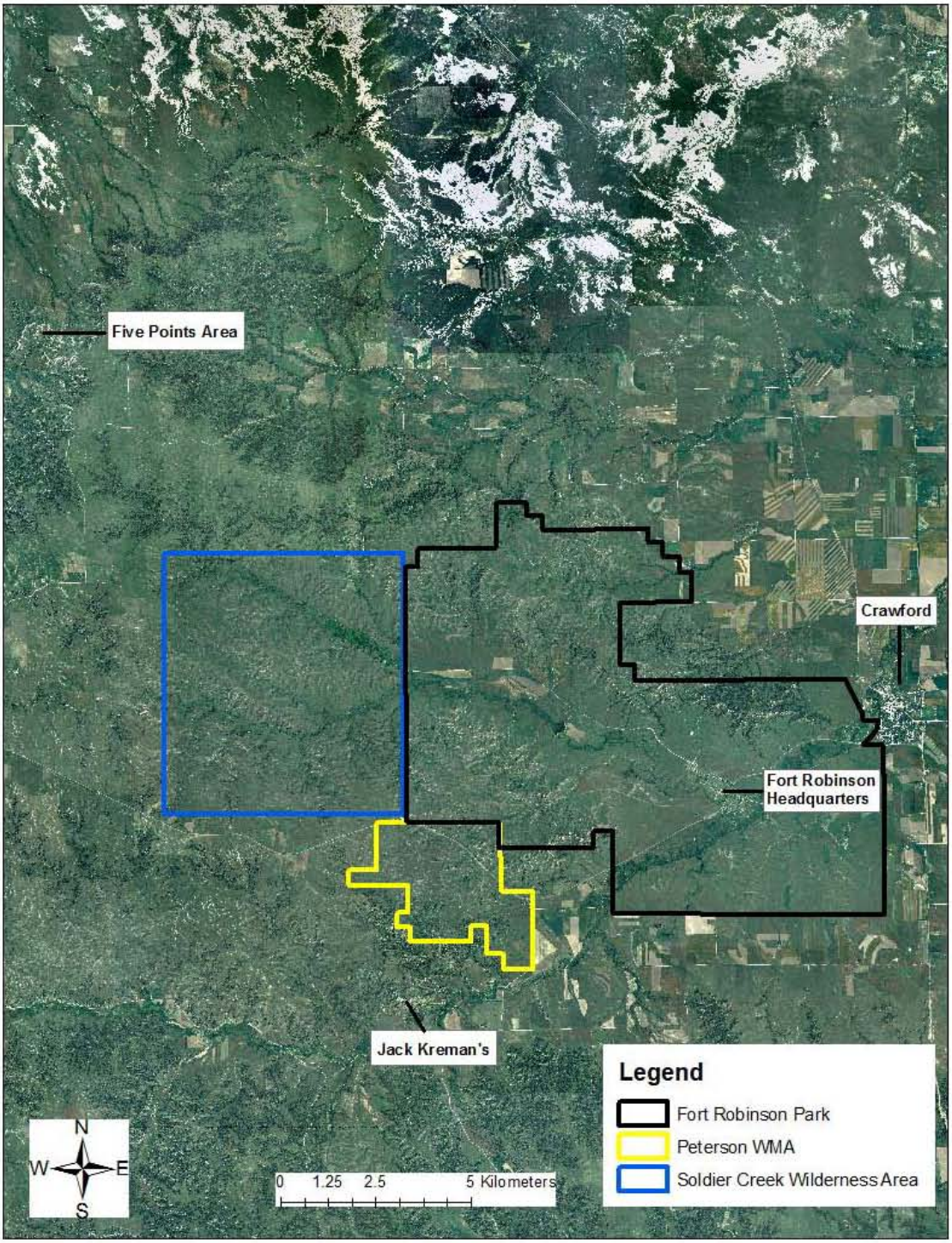


Figure 10. The 2006 ewe locations from the summer season at Fort Robinson State Park, Crawford Nebraska, USA.

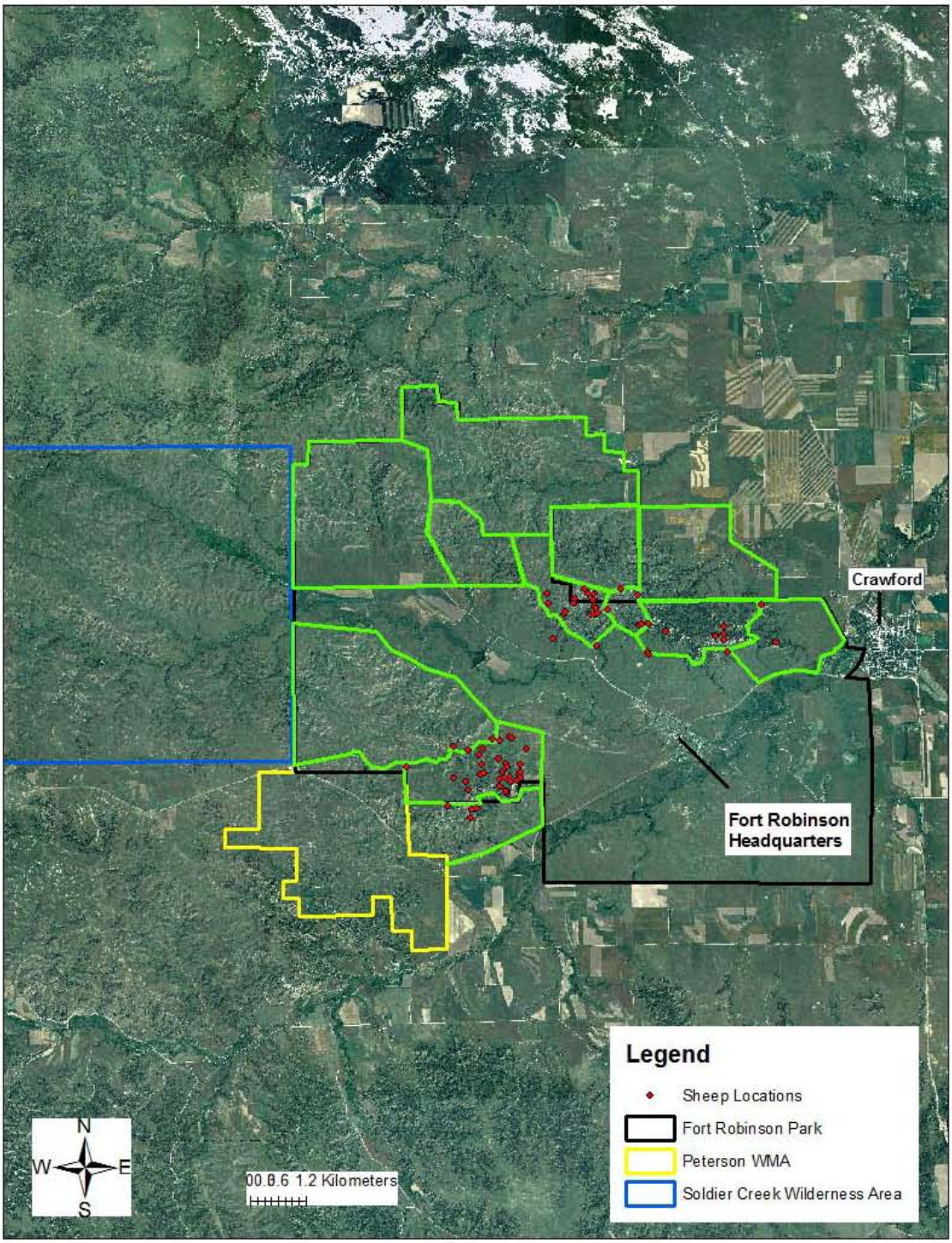


Figure 11. The 2007 ewe locations from the summer season at Fort Robinson State Park, Crawford Nebraska, USA.

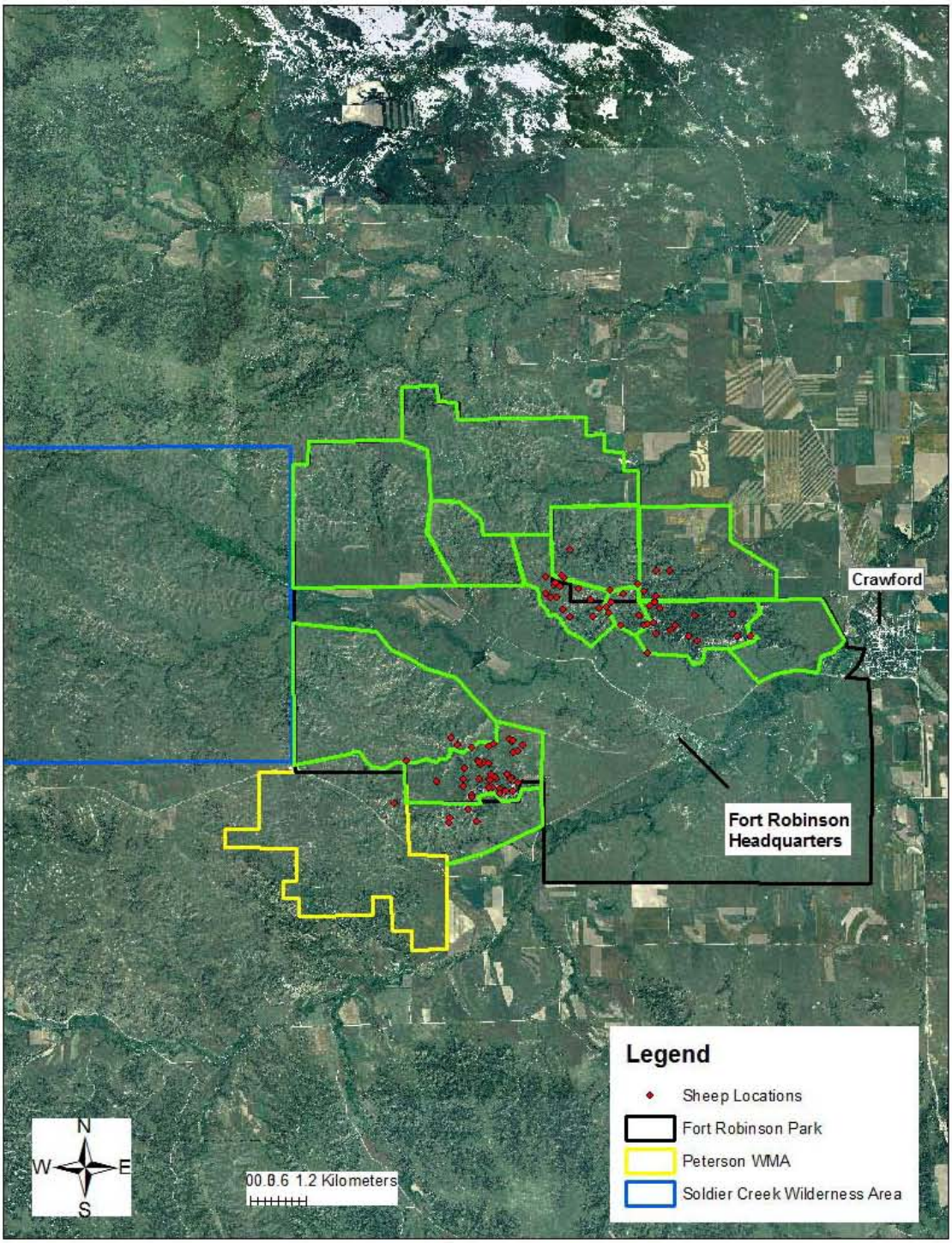


Figure 12. The 2006 ewe locations from the fall season at Fort Robinson State Park, Crawford Nebraska, USA.

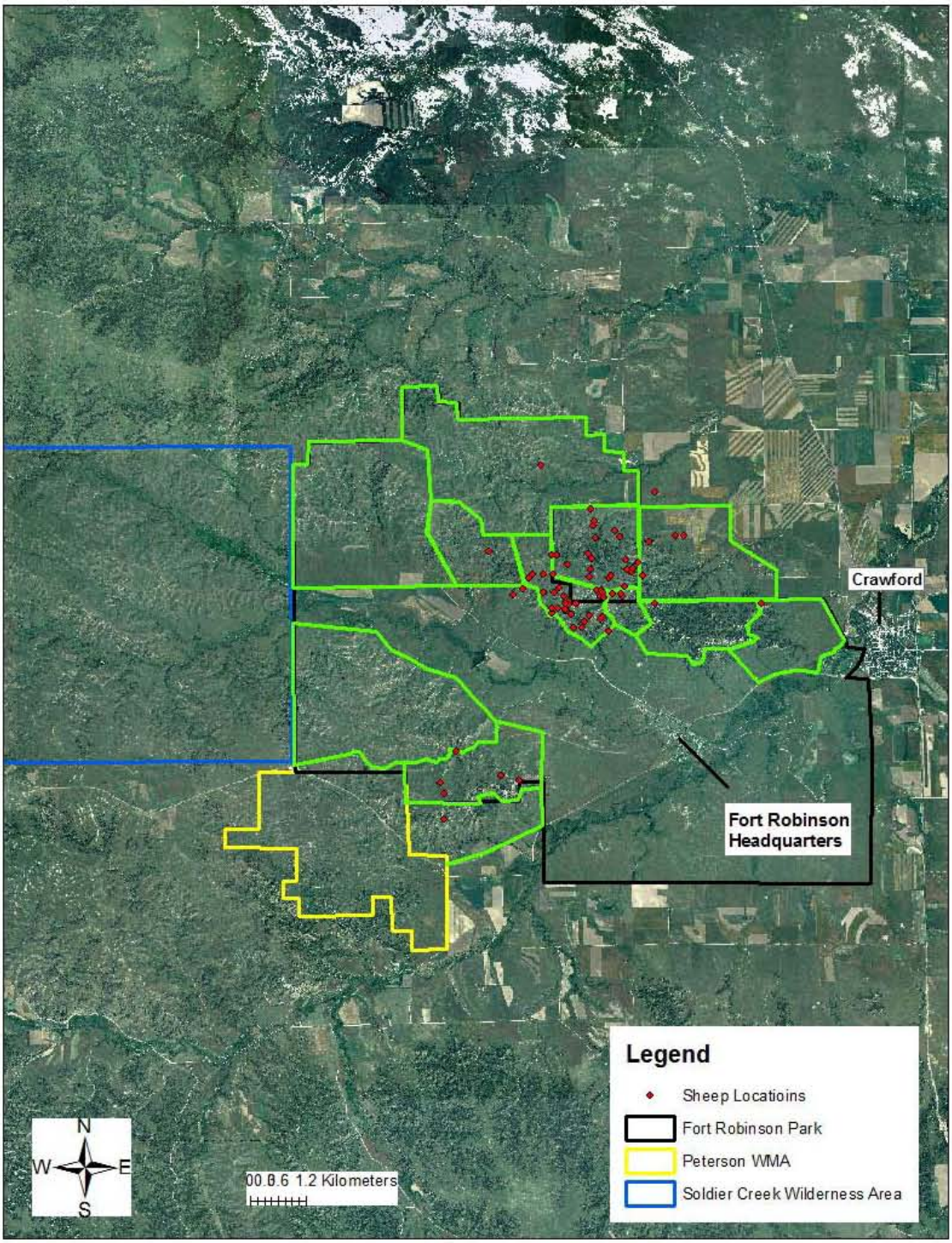


Figure 13. The 2007 ewe locations from the fall season at Fort Robinson State Park, Crawford Nebraska, USA.

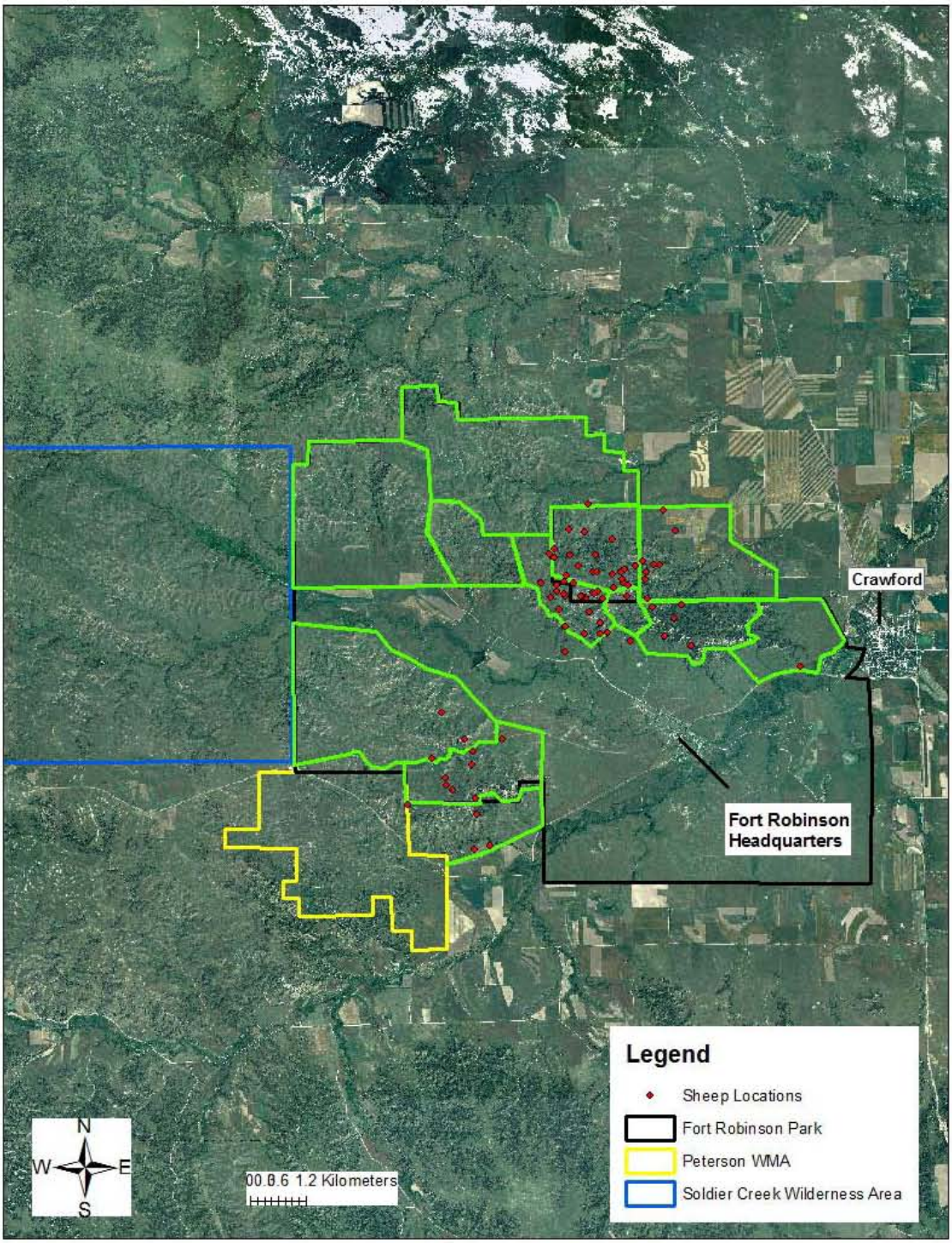
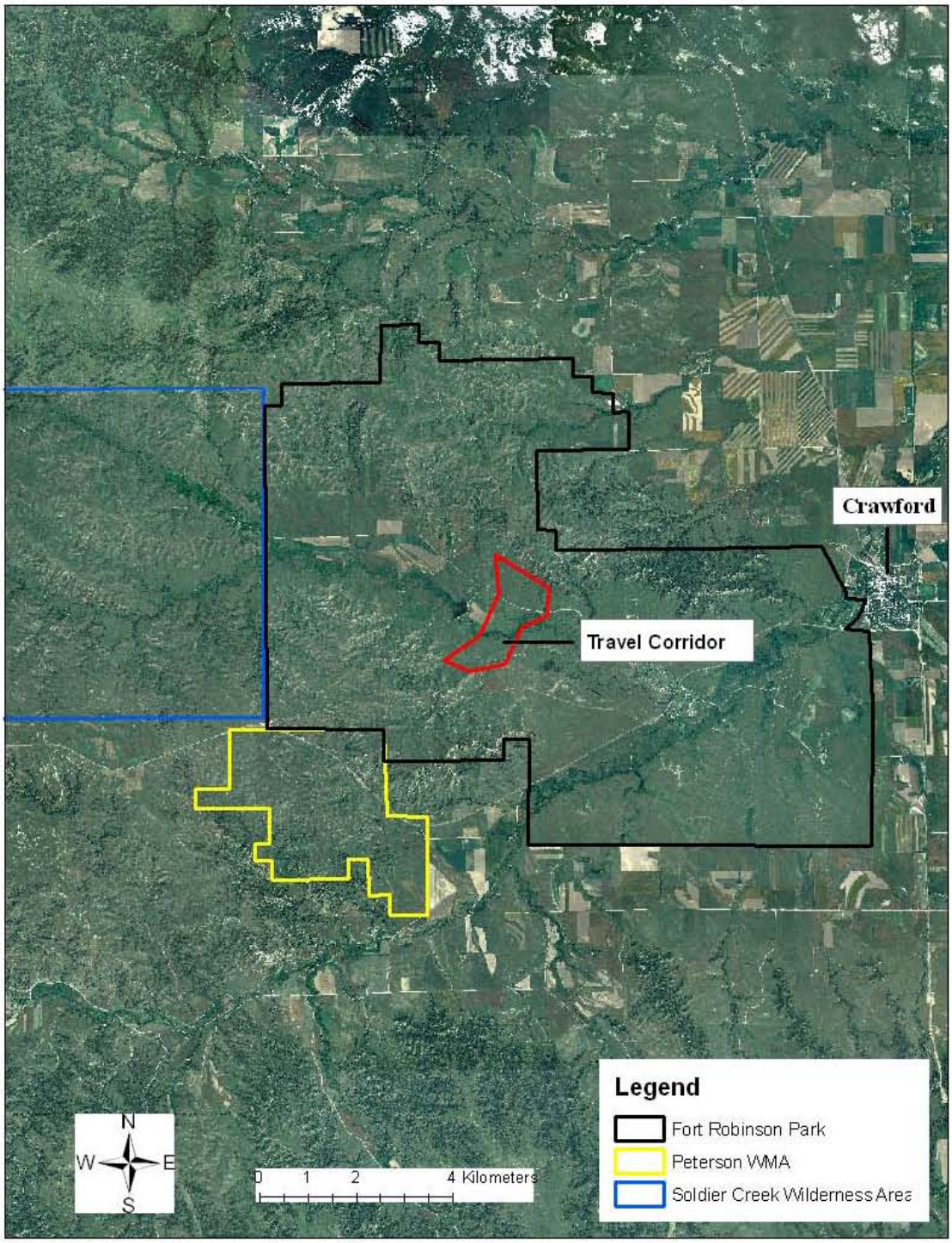


Figure 14. The only travel corridor used to travel between Smiley Canyon and Mexican Canyon at Fort Robinson State Park, Crawford Nebraska, USA.



The 2006 and 2007 winter seasons (December, January, and February) was similar to the spring movements of the ewes, which was moving back and forth from Mexican Canyon/School Section area through the Red Cloud Buttes, which lie to the east. There was also the occasional small group that would move over to Smiley Canyon for a week or two (Figures 15 & 16).

In contradiction to the movement pattern stated before, there was one adult ewe (Green 4) in 2007 that moved up to the Five Points area for a week around 3/13/07 (Figure 9). Green 4 then went back to Five Points about 5/30/07 and did not return to the Fort until 10/19/07. By 12/10/07, Green 4 was back at Five Points and was still there when the research ended February 29, 2007.

Unlike the ewes, the ram movement patterns and migrations were unfortunately not as well documented; this was due to only five rams being collared for one year (2007) and because the main concentration of this study was on the ewes and lambs. Also, the rams were not well documented because they spent more time than the ewes on private property that could not be accessed, thus no locations could be gathered. Still there was a pattern that could be seen. The spring season (March, April, May) found the rams scattered throughout the study area, which could partly be due to the capture effort that ended February 2007 (Figure 17). Typically around the beginning of April the rams tended to move back into their bachelor herds and away from the areas occupied by the ewes. During the summer season (June, July, August) the rams were found primarily in the North Smiley Canyon, Soldier Creek Wilderness area and private property north of the Soldier Creek Wilderness area (locations were not collected on private property) (Figure 17). There was a fire at the beginning part of July 2007 in the Soldier Creek Wilderness area, after this fire the rams tended to spend more time north of the Soldier Creek Wilderness area, which was private property. The reason for the movement north could possibly be because

Figure 15. The 2006 ewe locations from the winter season at Fort Robinson State Park, Crawford Nebraska, USA.

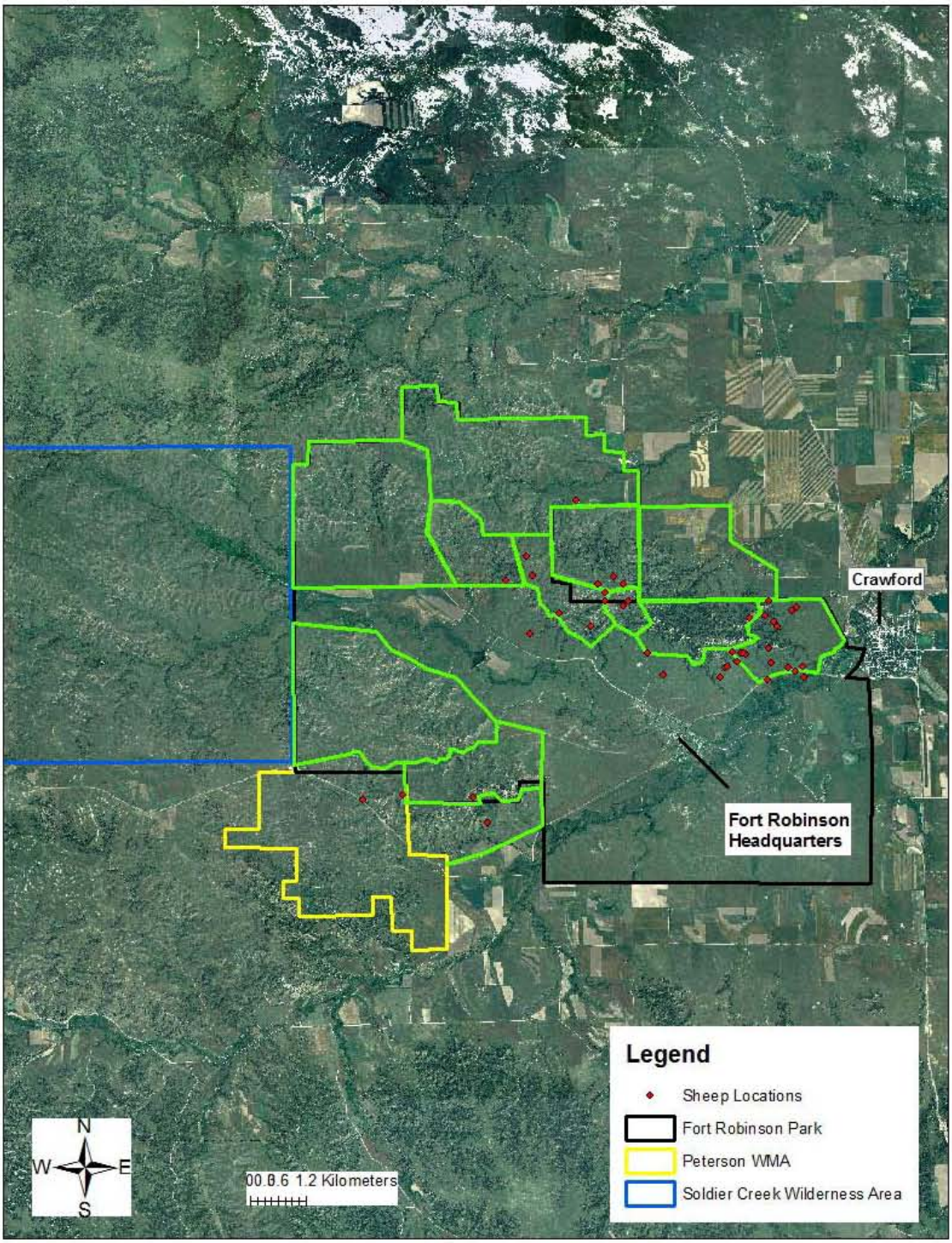


Figure 16. The 2007 ewe locations from the winter season at Fort Robinson State Park, Crawford Nebraska, USA.

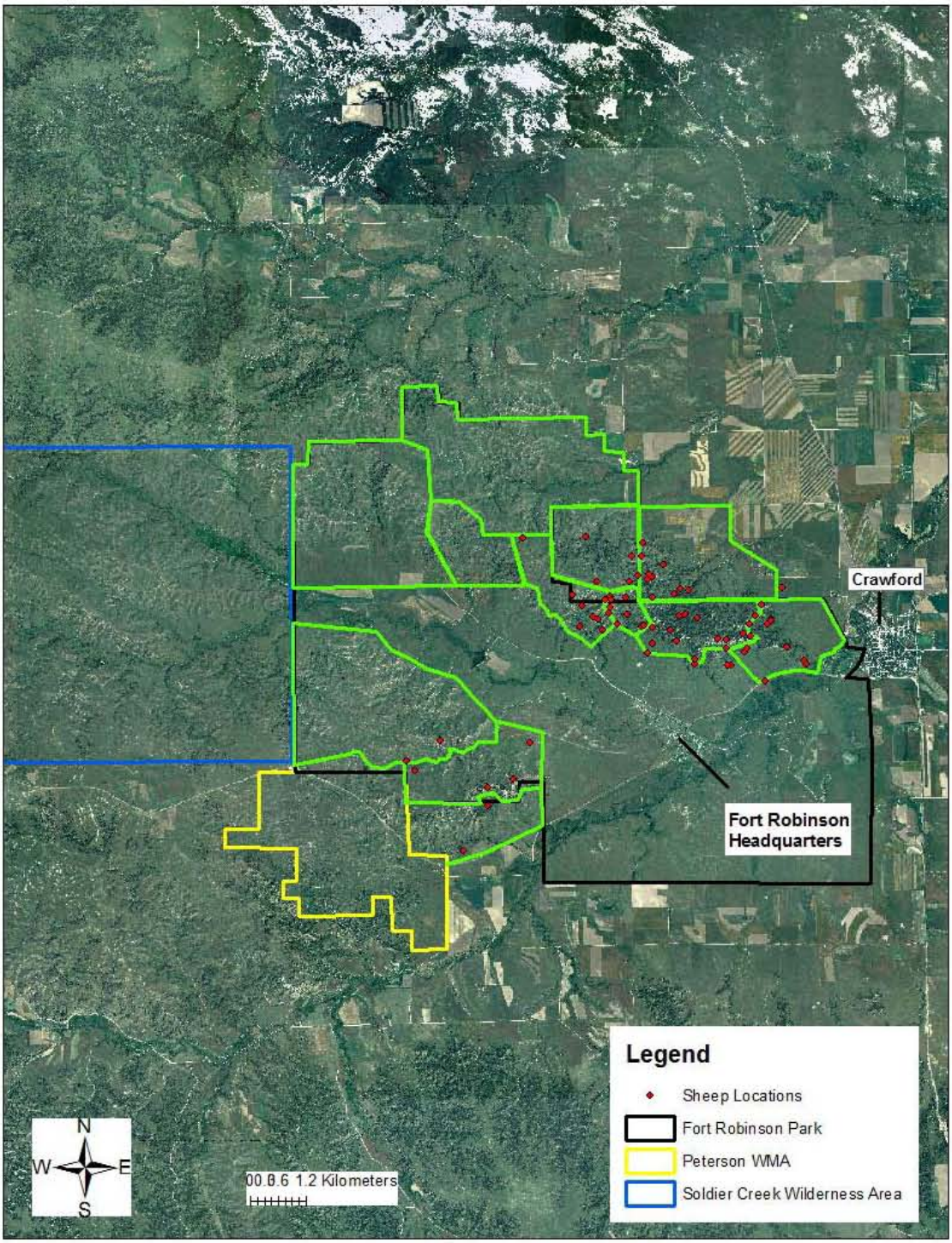
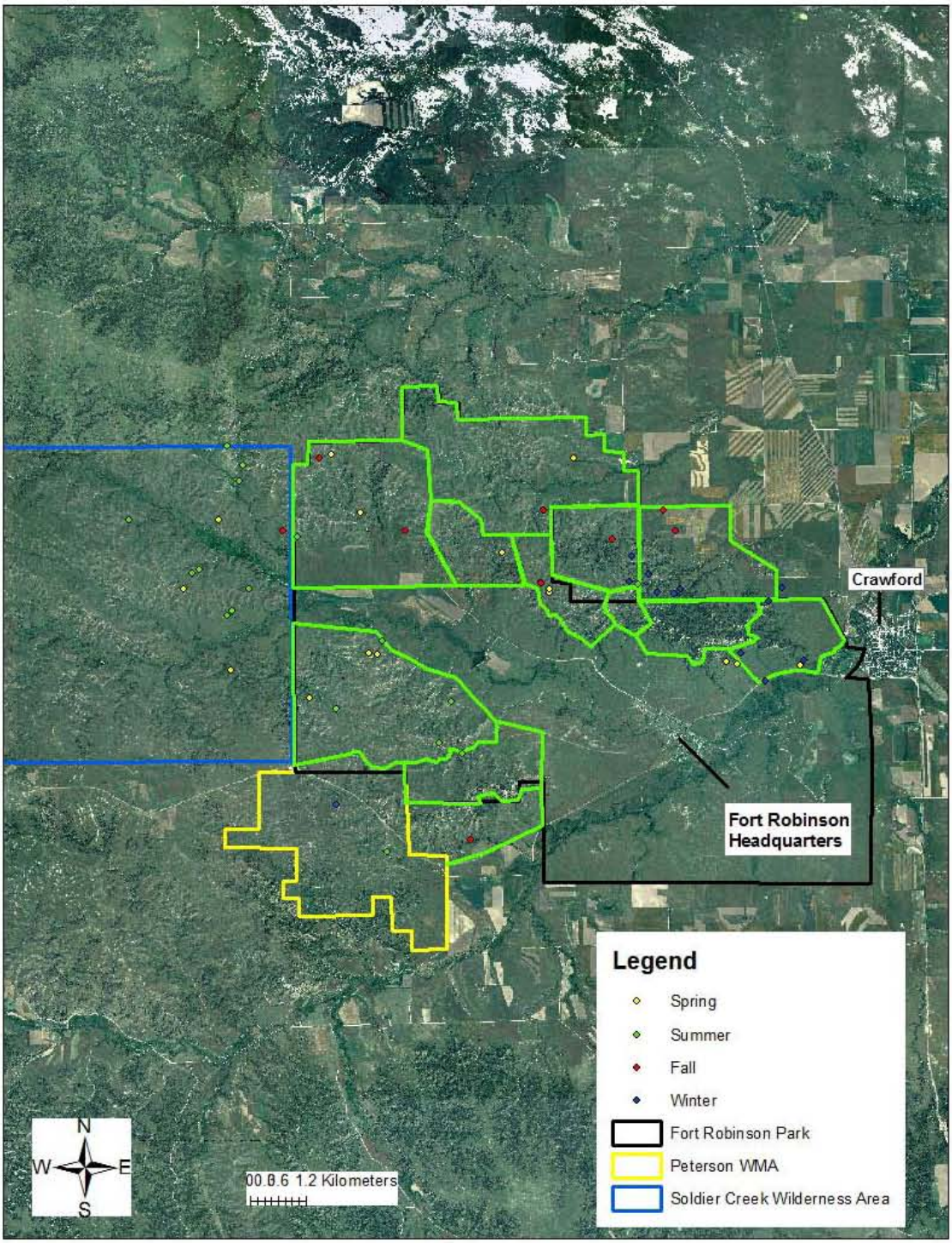


Figure 17. The seasonal locations of the rams from the 2007 year at Fort Robinson State Park, Crawford Nebraska, USA.



of all the human and motorized vehicle activity from the fire, because the Soldier Creek Wilderness area was typically a foot traffic only area. Another reason for the movement north could be the lack of forge due to the fire. During the fall (September, October, November), the rams were found in the Soldier Creek Wilderness area, James Ranch, Spring Creek and the private property to the north of the study area (locations were not collected on private property) (Figure 17). The rams did not start comingling with the ewes for the rut until the middle of November, which was common. The rams then spent the majority of the winter season (December, January, February) with the ewes (Figure 15, 16, 17). The rams started to split off from the ewes again around the beginning of February.

Home Range

Home range size could only be determined for the ewes because there was not enough ram locations to create valid home ranges (Appendix A8). Home range size results for the Kernel methods with least-squares cross validation smoothing parameter and MCP method can be seen in Table 27. Since bighorn sheep live in rugged terrain, a paired t-test was used to determine if there was a significant difference between surface areas figured in two dimensional (2D) and three dimensional (3D).

2D Home Ranges. - For both years of the study, the 95% adaptive kernel home range estimate ($\bar{x}$ = 47.2, SE = 4.6) and the 95% fixed kernel home range estimate ($\bar{x}$ = 42.6, SE = 4.4) were significantly different (Z = -2.803, P = 0.005) (Table 27, Figures 18 &19). For both years of the study, the 50% adaptive kernel home range estimate ($\bar{x}$ = 6.7, SE = 1.4) and the 50% fixed kernel home range estimate ($\bar{x}$ = 9.2, SE = 1.4) were significantly different (Z = 2.803, P = 0.005) (Table 27).

The 95% fixed kernel home range estimate for year one versus year two ($\bar{x}$ = 38.3, SE =

Figure 18. Bighorn sheep ewe home range using the adaptive kernel method at Fort Robinson State Park, Crawford Nebraska, USA.

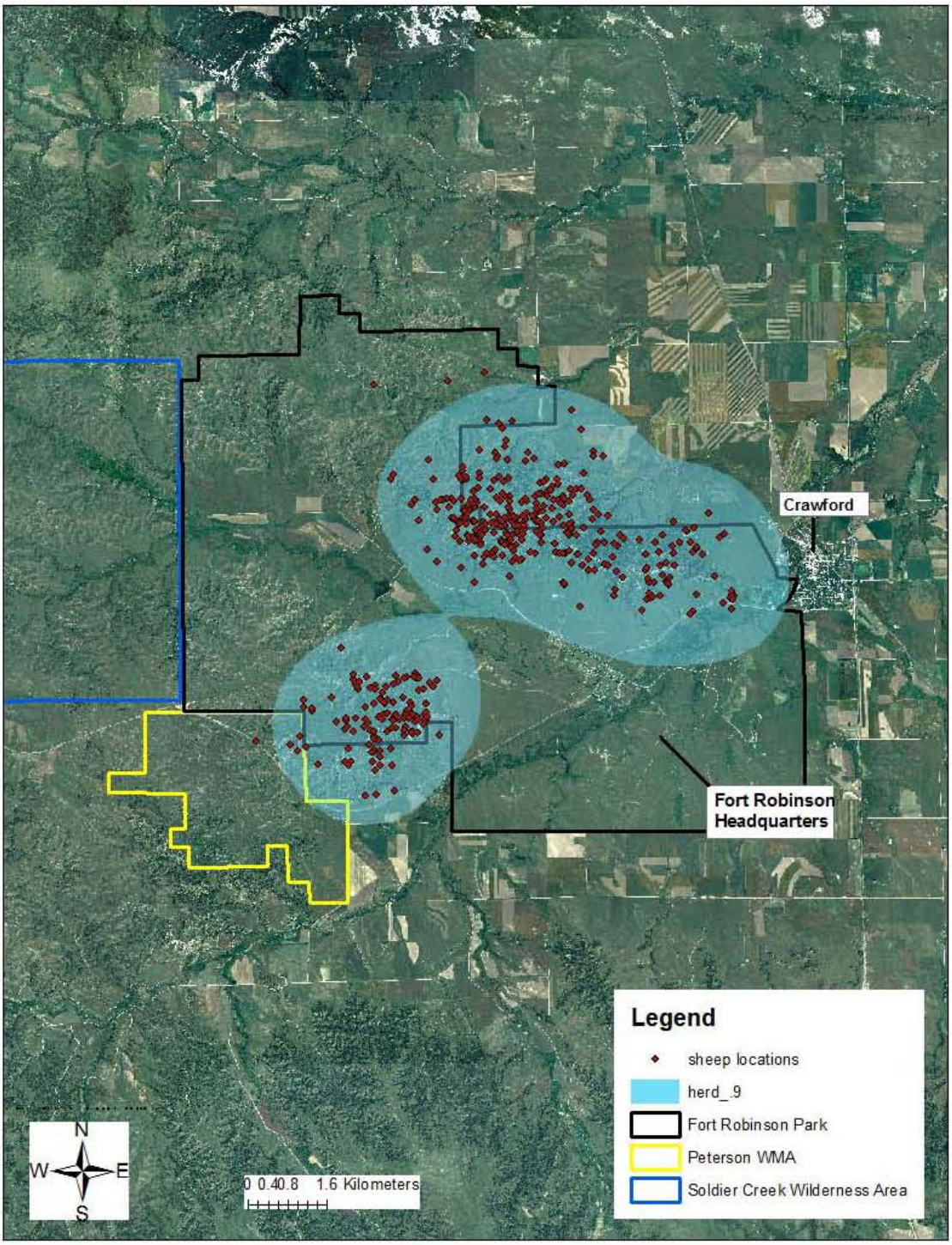
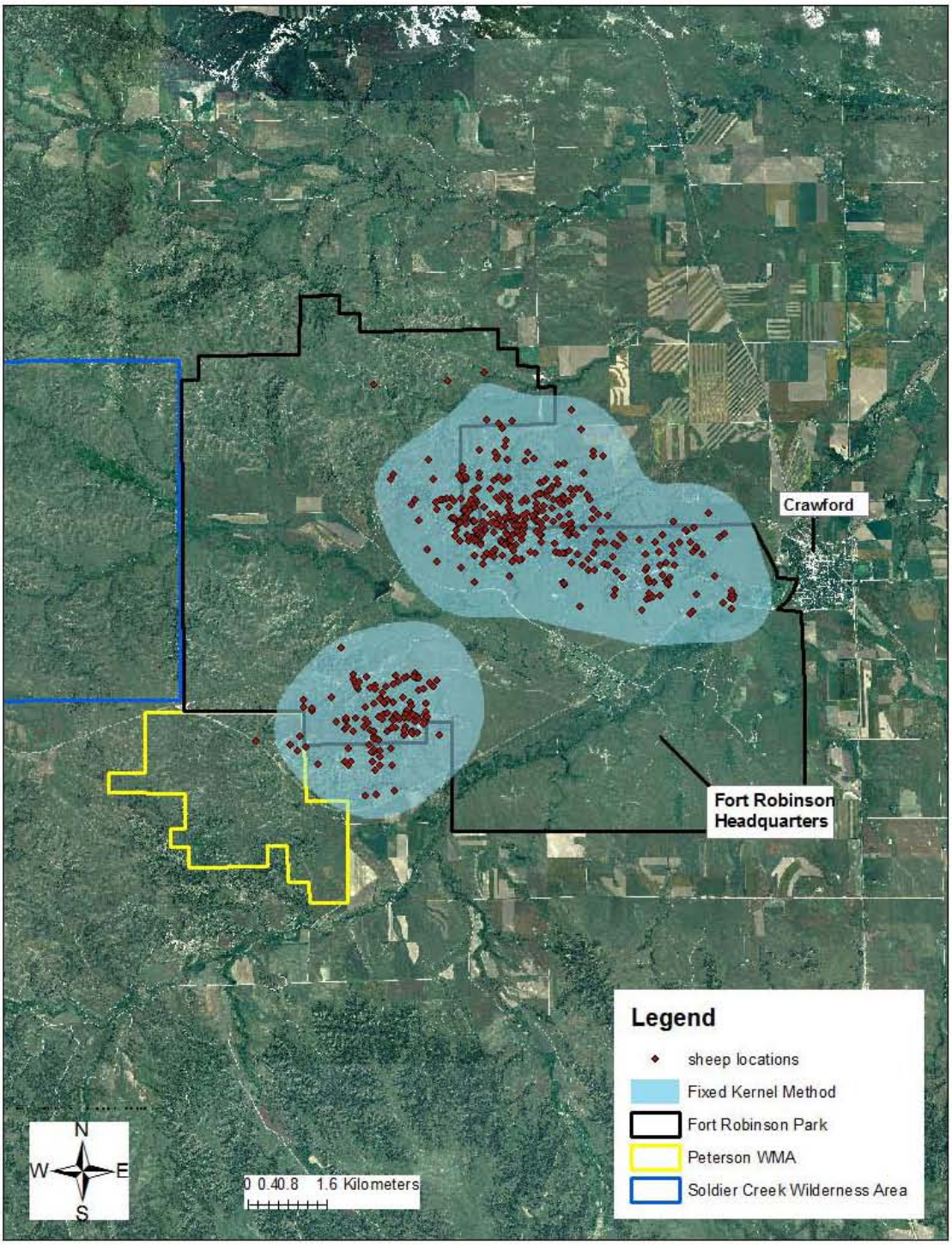


Figure 19. Bighorn sheep ewe home range using the fixed kernel method at Fort Robinson State Park, Crawford Nebraska, USA.



8.2; $\bar{x}$ = 46.1, SE = 5.7, respectively) were significantly different (Z = 2.090, P = 0.037) (Table 27). The 50% fixed kernel home range estimate for year one versus year two ($\bar{x}$ = 8.3, SE = 2.2; $\bar{x}$ = 10.5; SE = 1.6) did significantly differ (Z = 2.191, P = 0.028) (Table 27).

Whereas the 95% adaptive kernel home range estimate for year one versus year two ($\bar{x}$ = 45.1, SE = 10.3; $\bar{x}$ = 50.5, SE = 5.4) did not differ (Z = 1.682, P = 0.093) (Table 27). The 50% adaptive kernel home range estimate for year one versus year two ($\bar{x}$ = 6.5, SE = 2.3; $\bar{x}$ = 7.8, SE = 1.3) did not differ (Z = 1.376, P = 0.169) (Table 27).

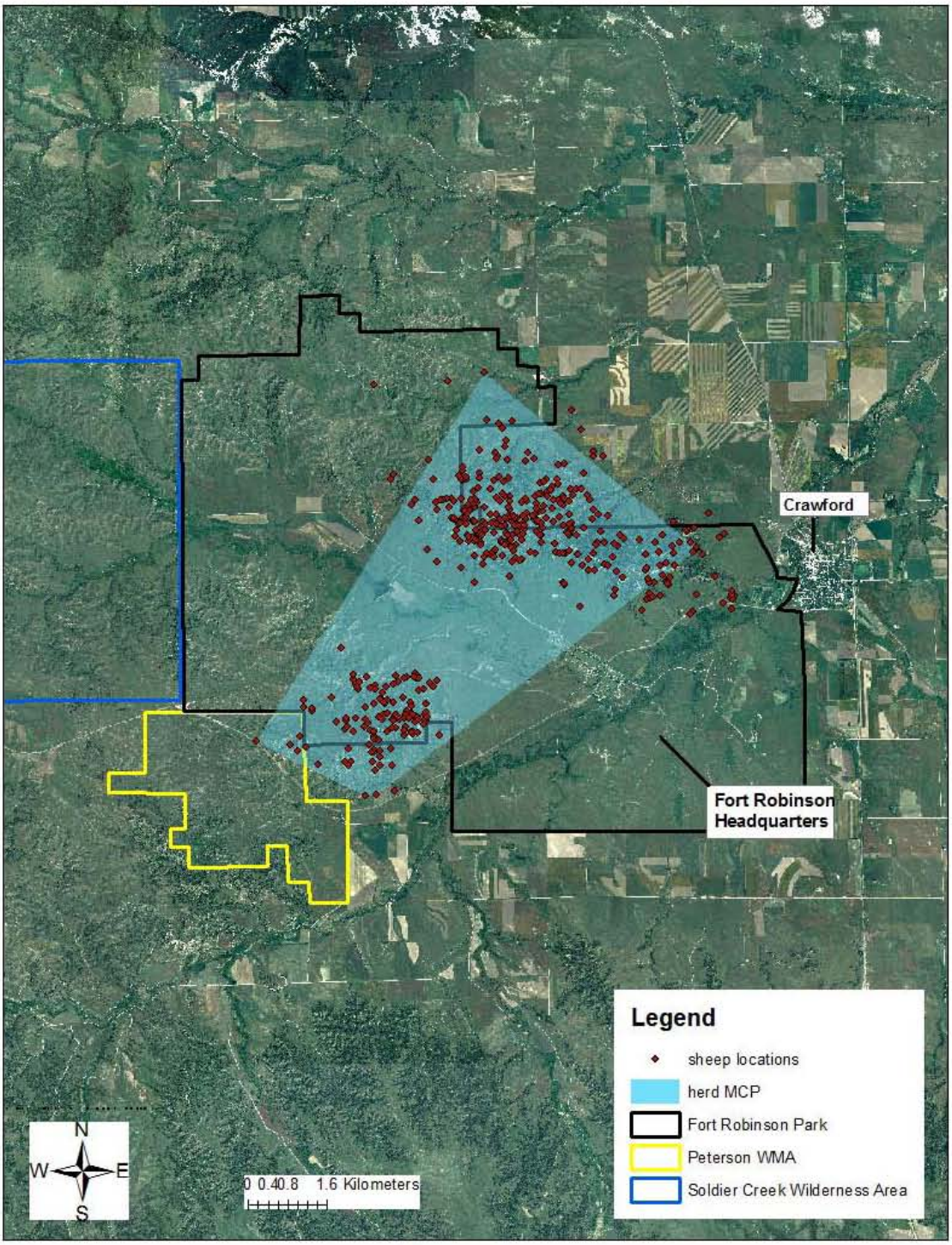
Since the adaptive kernel surface area was the only one that was not significantly different, it was compared with the MCP method to see if there was any difference in surface area. For both years of the study, the 95% adaptive kernel 2D surface area ($\bar{x}$ = 47.2, SE = 4.6) versus 95% MCP 2D surface area ($\bar{x}$ = 29.9, SE = 4.5, figure 20) was significantly different (P = 0.0001) (Figure 18 & 20). The 95% MCP 2D surface area year 1 ($\bar{x}$ = 25.0, SE = 5.4) versus the 95% MCP 2D surface area year 2 ($\bar{x}$ = 25.3, SE = 6.6) was not significantly different (P = 0.919).

Table 27. The two dimensional home range sizes in km² ($\bar{x}$) and the standard error (SE) in parenthesis for the bighorn sheep ewes at Fort Robinson State Park, Crawford Nebraska, USA during 2006-2007.

Model	Both Years	Year 1	Year 2
Fixed			
2D 95%	42.6 (4.4)	38.3 (8.2)	46.1 (5.7)
2D 50%	9.2 (1.4)	8.3 (2.2)	10.5 (1.6)
Adaptive			
2D 95%	47.2 (4.6)	45.1 (10.3)	50.5 (5.4)
2D 50%	6.7 (1.4)	6.5 (2.3)	7.8 (1.3)
MCP			
2D 95%	29.9 (4.5)	25.0 (5.4)	25.3 (6.6)

3D Home Ranges. - For both years of the study, the 95% adaptive kernel 3D surface area ($\bar{x}$ = 50.1, SE = 2.9) versus the 95% adaptive kernel 2D surface area ($\bar{x}$ = 47.2, SE = 4.6) was significantly different (P = 0.0274) (Table 28, Figures 18 & 21). The 95% adaptive kernel 3D

Figure 20. Bighorn sheep ewe home range using the modified convex polygon method at Fort Robinson State Park, Crawford Nebraska, USA.



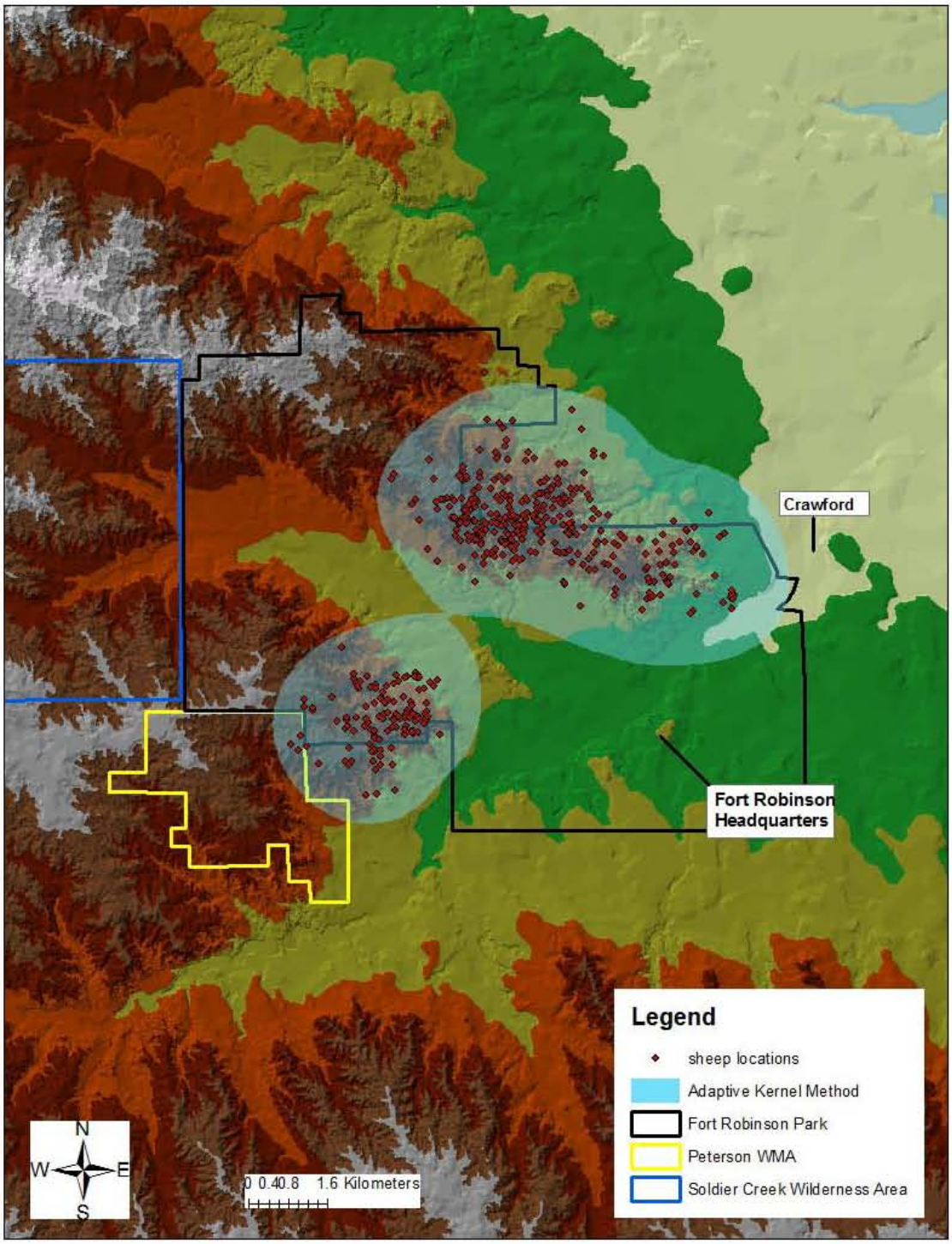
surface area year 1 ($\bar{x}$ = 46.6, SE = 10.4) versus 95% adaptive kernel 3D surface area year 2 ($\bar{x}$ = 59.0, SE = 23.0) was not significantly different (P = 0.114). For both years of the study, the 95% fixed kernel 3D surface area ($\bar{x}$ = 44.3, SE = 4.5) versus the 95% fixed kernel 2D surface area ($\bar{x}$ = 42.6, SE = 4.4) was significantly different (P = 0.0001). However the 95% fixed kernel 3D surface area year 1 ($\bar{x}$ = 39.6, SE = 8.5) versus 95% adaptive kernel 3D surface area year 2 ($\bar{x}$ = 52.6, SE = 15.1) was significantly different (P = 0.03126). Both years of the study, 95% adaptive kernel 3D surface area ($\bar{x}$ = 50.1, SE = 2.9) versus the 95% fixed kernel 3D surface area ($\bar{x}$ = 44.3, SE = 4.5) was significantly different (P = 0.0016).

Table 28. The two dimensional and three dimensional home range sizes in km² ($\bar{x}$) and the standard error (SE) in parenthesis for the bighorn sheep ewes at Fort Robinson State Park, Crawford Nebraska, USA during 2006-2007.

Model	Both Years	Year 1	Year 2
Fixed			
2D 95%	42.6 (4.4)	38.3 (8.2)	46.1 (5.7)
3D 95%	44.3 (4.5)	39.6 (8.5)	52.6 (15.1)
Adaptive			
2D 95%	47.2 (4.6)	45.1 (10.3)	50.5 (5.4)
3D 95%	50.1 (2.9)	46.6 (10.4)	59.0 (23.0)

The 95% adaptive and fixed kernel home range sizes on an individual bases for the Fort Robinson bighorn sheep ewes ranged between 26.9 km² and 122 km². The home range for the ewes consisted of two separate series of buttes, Smiley Canyon and Red Cloud Buttes, found in Fort Robinson State Park. The movement patterns of the ewes showed a seasonal shift between thesetwo series of buttes, which indicates the Red Cloud Buttes in the Northeastern area, was primarily used during the end of fall through spring, while the Smiley Canyon Buttes in the Southwestern area was used heavily through the summer. The sheep only used one travel corridor, which was the shortest distance, to get between Smiley Canyon and Red Cloud Buttes (Figures 13, 18 & 19). This movement pattern was similar to Klinksiek's (2004) data from 2002 and 2003 (Appendix A9).

Figure 21. A three-dimensional view of the bighorn sheep ewe home range with the adaptive kernel method At Fort Robinson State Park, Crawford Nebraska, USA.



DISCUSSION

The tracking of both ewes and rams proved to be too much for this study because of the large movements the rams displayed along with the extensive time needed for collecting bite count observations and fecal samples, thus it was decided that the ewes would be the main focus. The results of the ewe's seasonal movements indicated that major movements occurred between two series of buttes located with Fort Robinson State Park, Smiley Canyon and Red Cloud Buttes. These results were expected since past sightings of bighorn sheep and Klinksiek's (2004) data showed bighorn sheep usages generally in these areas. Unfortunately the exact locations and movements of the ewes on private property were not documented as thoroughly as on public property, though beneficially, the general areas were identified when the sheep were off of public property. The amount of private property used was higher than expected with the rams, more information needs to be collected to determine exactly how much and where the rams spend the majority of their time.

The home range results indicated that the adaptive kernel method fit the data the best, which agrees with Kernohan et al. (1998) that the adaptive kernel method was very accurate at representing habitat distribution and that the kernel method was preferred over the minimum convex polygon method. These results also agree with Worton's (1989) study that the adaptive kernel method with the least-squares cross-validation produced the best results overall. The fixed kernel method did show tighter isopleths to the data than the adaptive kernel method, but there was a significant difference between the two years of the study ($Z = 2.090$, $P = 0.037$). Thus the fixed kernel method was not accepted, which does not agree with Seaman and Powell's (1996) study that stated the fixed kernel method gave the lowest errors on surface area. One possible reason could be the larger animal movements influenced by the capture operation that

took place between the two years of the study. Another reason could be that only data from 10 ewes, which individual locations ranged from 24 to 66 in one year, out of 19 total ewes could be used for the study. Thus, there were barely enough locations to run the home range models on yearly bases, but not enough locations to run the models seasonally as Seaman et al. (1999) suggests at least 30 locations are needed to run the kernel models, but 50 locations are preferred. Only one individual was below 30 locations and only for one year of the study (Appendix A8).

The surface area results indicated that the 95% isopleths 3D surface area was significantly different from the 95% isopleths 2D surface area no matter which kernel method was used, which agrees with Stone et al. (1997), Jenness (2004) and Zimmerman (2008). The 95% 3D adaptive kernel method more accurately represents the Fort Robinson bighorn sheep ewe's annual home range size (50.1 km^2) because it was significantly different than the 95% 2D adaptive kernel method surface area and the 95% 3D fixed kernel method surface area. The minimum convex polygon method was not utilized because the surface area calculated from the method was low compared to the kernel methods and when visually represented it included large areas of land that were not utilized by bighorn sheep, which agrees with Zimmerman's (2008) work with a low elevation herd in South Dakota.

The adaptive kernel home range sizes for the Fort Robinson bighorn sheep were larger than the 95% (15.5-31.3 km^2) and 50% (1.8-3.9 km^2) adaptive kernel home range sizes of Badlands National Park, South Dakota (Zimmerman 2008). Both of these herds are low elevation Rocky Mountain bighorn sheep (*Ovis canadensis canadensis*), thus there home range sizes should be similar. Unexpectedly the adaptive kernel home range sizes at Fort Robinson bighorn sheep compares more with the 95% (34.5-65.98 km^2) and the 50% (5.14-10.01 km^2) adaptive kernel home-range sizes of the desert bighorn sheep (*Ovis canadensis nelsoni*) at the

Mojave Desert, California (Oehler et al. 2003). This suggests that the habitat at Fort Robinson is in poor condition, because the larger home-range sizes of desert bighorns compared with northern bighorn subspecies may be expected due to more widely distributed resources in desert ecosystems (Oehler et al. 2003).

MANAGEMENT IMPLICATIOINS

As expected this study did not answer the question to the sudden declining population, but this study suggests one possible restriction of the herd. The first management issue is the large home range that indicates poor habitat, which the Fort Robinson bighorn sheep herd is occupying. Because of this, the herd maybe exceeding the carrying capacity of the area thus is becoming more susceptible to diseases, which could be the reason for the population decline.

The second management issue would be the rams home range and movements. Unfortunately there was not enough time to collect enough data to run home range models on the rams. This study along with Klinksiek's (2004) data gives a good indication where and how the rams move, but this data does not indicate where on private property the rams go or how long they spend there. It would also be beneficial to use GPS collars on the rams along with the VHF collars that are already on them if this study was ever done because of access on private property. I feel this data would be vital in helping to discover what agent or agents are responsible for the herd's population decline.

The third management issue is the movement of both the ewes and rams off of public property. As the results have indicated, the Fort Robinson bighorn ewe herd primarily uses Smiley Canyon and Red Cloud buttes, which occurs within the state park boundaries, but both the ewes and the rams were documented moving off of public property. This is a concern due to the possible transfer of disease between bighorn sheep and livestock. It would only take one

individual to contract a disease, potentially pasturella pneumonia which can devastate an entire bighorn sheep population.

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APPENDIX

Appendix A1. Scientific names of plant species in bite count and vegetation surveys.

Plant, Common Name	Scientific Name
alfalfa	*Medicago spp*. L.
all wheatgrass	*Agropyron spp.* Gaertn.
American licorice	*Glycyrrhiza lepidota* Pursh
American vetch	*Vicia americana* Muhl. ex Willd.
annual mustard	*Brassica* spp. L.
annual sunflower	*Helianthus annuus* L.
bastard toadflax	*Linaria spp*. Mill.
bergamat	*Monarda fistulosa* L.
blackroot sedge	*Carex filifolia* Nutt.
blue grama	*Bouteloua gracilis* (Willd ex Kunth) Lag. ex Griffiths
blue-eyed grass	*Sisyrinchium angustifolium* P. Mill.
brittle cactus	*Opuntia spp.* P. Mill.
broom snakeweed	*Gutierrezia sarothrae* (Pursh) Britton & Rusby
bush morningglory	*Ipomoea leptophylla* Torr.
Canada thistle	*Cirsium arvense* (L.) Scop.
chokecherry	*Prunus virginiana* L.
cinquefoil spp.	*Potentilla spp.* L.
crazyweed	*Oxytropis spp.* DC.
cudweed sagewort	*Artemisia ludoviciana* Ntt.
curlycup gumweed	*Grindelia squarrosa* (Pursh) Dun.
dandelion	*Taraxacum officinale* Weber
deathcamas	*Zigadenus venenosus* S. Wats.
desert stickseed	*Lappula echinata* Gilib.
dog’s-tooth-violet	*Erythronium spp*. L.
downy brome	*Bromus tectorum* L.
false boneset	*Kuhnia spp*. L.
false solomonseal	*Smilacina spp*. Desf.
field chickweed	*Cerastium arvense* L.
flax spp.	*Linum spp.* L.
fleabane	*Erigeron spp. L.*
fringed sagebrush	*Artemisia frigida* Willd.
gayfeather	*Liatris punctata* Hook.
goat's beard	*Tragopogon dubius* Scop.
goldenpea	*Thermopsis rhombifolia* Nutt.
goldenrod	*Solidago spp.* L.
ground plum	*Astragalus crassicarpus* Nutt.
hairy goldaster	*Chrysopsis villosa* (Pursh) Nutt.
harebell	*Campanula rotundifolia* L.

Appendix A1 continued. Scientific names of plant species in bite count and vegetation surveys.

Plant, Common Name	Scientific Name
hawk's beard	*Crepis spp*. L.
hoary vervain	*Verbena stricta* Vent.
horseweed	*Conyza canadensis* (L.) Cronq.
Junegrass	*Koeleria cristata* (Lam.) Beauv.
Kentucky bluegrass	*Poa pratensis* L.
lamb's quarters	*Chenopodium album* L.
lambstoungue groundsel	*Senecio integerrimus* Nutt.
little bluestem	*Schizachyrium scoparium* (Michx.) Nash
mullein	*Verbascum thapsus* L.
needleandthread	*Stipa comata* Trin. & Rupr.
pasque flower	*Anemone multifida* Poir.
peppergrass	*Lepidium spp.* L.
plains muhly	*Muhlenbergia cuspidata* (Torr.) Rydb.
plains phlox	*Phlox andicola* Nutt. ex A. Gray
poison ivy	*Toxicodendron spp*. P. Mill
prairie milkvetch	*Astragalus spp*. L.
prairie sandreed	*Calamovilfa longifolia* (Hook.) Scribn.
prickly lettuce	*Lactuca serriola* L.
pricklypear cactus	*Opuntia macrorhiza* Engelm.
primrose	*Oenothera spp.* L.
prostrate knotweed	*Polygonum aviculare* L.
puccoon	*Lithospermum canescens* (Michx.) Lehm.
purple prairieclover	*Dalea purpurea* Vent.
rock cress	*Arabis spp.* L.
Rockymountain beeplant	*Cleome serrulata* Pursh
Russian thistle	*Salsola iberica* Senn. & Pau
sand bluestem	*Andropogon gerardii* subsp. *halli* (Hack) J. Wipff
sand dropseed	*Sporobolus cryptandrus* R. Br.
sand sagebrush	*Artemisia filifolia* Torr.
scarlet gaura	*Gaura coccinea* Pursh
scarlet globemallow	*Sphaeralcea coccinea* (Nutt.) Rydb.
Scribners panicum	*Dichanthelium oligosanthes* (Schult.) Gould
sego lily	*Calochortus nuttallii* T.&G.
shelleaf penstomon	*Penstemon grandiflorus* Nutt.
Shinneroseris rostrata	*Shinneroseris rostrata* (A. Gray) Tomb.
sideoats grama	*Bouteloua curtipendula* (Michx.) Torr.
silverleaf bladderpod	*Lesquerella spp.* S. Wats.
silverleaf scurfpea	*Psoralea argophylla* Pursh
sixweeks fescue	*Vulpia octoflora* (Walter) Rybd.
skeletonweed	*Lygodesmia spp*. D. Don

Appendix A1 continued. Scientific names of plant species in bite count and vegetation surveys.

Plant, Common Name	Scientific Name
skunkbrush sumac	*Rhus aromatica* Aiton
slimflower scurfpea	*Psoralea linearifolia* T. & G.
smooth brome	*Bromus inermis* Leyss.
snowberry	*Symphoricarpos spp*. Duham.
spiderwort	*Tradescantia occidentalis* (Britt.) Smyth.
sun sedge	*Carex spp.* L.
sweetclover	*Melilotus spp*. P. Mill.
Texas Croton	*Croton texensis* (Klotzsch) Muell. Arg.
textile onion	*Allium textile* A. Nels. & Macbr.
thistle spp.	*Cirsium spp*. P. Mill.
tumble mustard	*Sisymbrium altissimum* L.
Virginia groundcherry	*Physalis virginiana* P. Mill.
wavyleaf thistle	*Cirsium undulatum* (Nutt.) Spreng.
western ragweed	*Ambrosia psilostachya* DC.
western wallflower	*Erysimum asperum* (Nutt.) DC.
white aster	*Aster ericoides* L.
white beardstongue	*Penstemon albidus* Nutt.
white priarieclover	*Dalea candida* Michx. ex Willd.
whorled milkweed	*Asclepias verticillata* L.
wilcox panicum	*Dichanthelium wilcoxianum* (Vasey) Freckmann
wild rose	*Rosa woodsii* Lindle.
winter wheat	*Triticum aestivum* L.
woolly plantain	*Plantago patagonica* Jcq.
yarrow	*Achillea millefolium* L.
yucca	*Yucca glauca* Nutt.

Appendix A2. Interpretation of plant species in the fecal samples.

Plant, Common Name	Scientific Name
any forb seed	seed
asteraceae seeds	composite seed
bladderpod	*Lesquerella* type
bluegrass	*Poa*
brome grass	*Bromus*
Bryum spp. Hedw.	Moss
Buffaloberry - Russian olive or silverberry	*Shepherdia-Eleagnus* type
cherry, peach or plum	*Prunus*
chokecherry	*Prunus virginiana*
common sunflower	*Helianthus annuus*
cudweed sagewort	*Artemisia ludoviciana*
dotted gayfeather	*Liatris punctata*
False or globe mallow	*Sphaeralcea* type
fringed sagebrush	*Artemisia frigida*
golden aster	*Chrysopsis villosa*
grama and dropseed	*Bouteloua-Sporobolus* type
grass seed	Grass seed and glume
junegrass	*Koeleria*
knotweed	*Polygonum aviculare*
needleandthread	*Stipa comata*
parts of flowers	flower
penstemon	*Penstemon*
phlox	*Phlox*
Pine	*Pinus type*
Polemonium family	*Gilia* type
prairieclover	*Dalea*
prickly pear, cholla	*Opuntia* type
Russian thistle	*Salsola iberica*
scurfpea	*Psoralea*
sedges	*Carex*
true thistles	*Cirsium*
wedelia (asteraceae)	*Zexmenia* type
western ragweed	*Ambrosia psilostachya*
wheatgrass	*Agropyron*
wild lettuce	*Lactuca serriola*
willow	*Salix* type
wormwood, sage and mugwort	*Artemisia*
yucca	*Yucca glauca*

Appendix A3. Vegetation frequency and percent green-up data.

Vegetagtion Transect Locations (Figure 3)

Waypoint	Name	Beginning	End
MT 1	Mexican Canyon Transect 1	N-42.69905 W-103.50191	N-42.69851 W-103.50666
MT 2	Mexican Canyon Transect 2	N-42.68994 W-103.49569	N-42.69217 W-103.49739
ST 1	Smiley Canyon Transect 1	N-42.65779 W-103.51133	N-42.65887 W-103.51456
ST 2	Smiley Canyon Transect 2	N-42.65862 W-103.51174	N-42.65931 W-103.51450
FT 1	Saddle Rock Flats Transect 1	N-42.68872 W-103.44003	N-42.69036 W-103.44000
FT 2	Saddle Rock Flats Transect 2	N-42.68819 W-103.43562	N-42.68732 W-103.43877
FT 3	Saddle Rock Flats Transect 3	N-42.68415 W-103.44140	N-42.68416 W-103.44051
FT 4	Saddle Rock Flats Transect 4	N-42.68264 W-103.43761	N-42.68087 W-103.44289
WT 1	Smiley Canyon Windmill Transect 1	N-42.66655 W-103.51482	N-42.66725 W-103.51199
WT 2	Smiley Canyon Windmill Transect 2	N-42.66647 W-103.51472	N-42.66703 W-103.51180
WT 3	Smiley Canyon Windmill Transect 3	N-42.66663 W-103.51170	N-42.66595 W-103.51450

Appendix A4. Vegetation frequency and percent green-up data.

Mexican Canyon Transect 1 – 3/6/07

Plot #	Plant Name	Green up
1	downy Brome	50
	hairy goldaster	10
	needleandthread	5
	slimflower scurfpea	0
	yucca	100
2	downy Brome	5
	finge sagebrush	15
	hairy goldaster	0
	needleandthread	5
	white aster	0
	prairie sandreed	0
3	black root	20
	blue grama	0
	downy Brome	20
	junegrass	5
	white aster	0
	prairie sandreed	0
	sun sedge	70
	western ragweed	0
4	black root	15
	blue grama	5
	hairy goldaster	0
	junegrass	0
	moss	60
	white aster	0
	prairie sandreed	0
	wheatgrass	40
5	downy Brome	5
	goat's beard	0
	Kentucky bluegrass	0
	little bluestem	0
	needleandthread	0
	sun sedge	50
	wheatgrass	30
	wilcox panicum	0
6	downy Brome	40
	finge sagebrush	65
	goat's beard	100
	Kentucky bluegrass	0
	sand bluestem	0
	sun sedge	70
	western ragweed	0
	wheatgrass	30
	wilcox panicum	30
7	hairy goldaster	0
	Kentucky bluegrass	0
	needleandthread	5
	prairie sandreed	0
	skeleton rush	0
7	sun sedge	50
	western ragweed	0
	wilcox panicum	15
8	downy Brome	30
	horseweed	0
	prairie sandreed	0
	western ragweed	0
9	black root	5
	downy Brome	5
	moss	80
	needleandthread	0
	prairie sandreed	0
	western ragweed	0
	wheatgrass	10
10	black root	10
	downy Brome	15
	Kentucky bluegrass	0
	needleandthread	0
	skeleton rush	0
	wheatgrass	20
11	finge sagebrush	10
	hairy goldaster	0
	skunkbrush sumac	0
12	black root	15
	hairy goldaster	0
	needleandthread	0
	pricklypear cactus	60
	sand bluestem	0
	western ragweed	0
	wheatgrass	60
13	Kentucky bluegrass	0
	little bluestem	0
	sand bluestem	0
	sideoats grama	0
	western ragweed	0
	wheatgrass	15
14	downy Brome	40
	sand bluestem	0
	western ragweed	0
15	downy Brome	20
	moss	85
	prairie sandreed	0
	sand bluestem	0
	sun sedge	40
	wilcox panicum	0
16	downy Brome	5
	prairie sandreed	0
	sand bluestem	0

Appendix A4 continued. Vegetation frequency and percent green-up data.

Mexican Canyon Transect 1 – 3/6/07

Plot #	Plant Name	Green up
16	sun sedge	30
	western ragweed	0
17	downy Brome	10
	Kentucky bluegrass	30
	wheatgrass	30
18	Kentucky bluegrass	20
	white aster	0
	sun sedge	60
	western ragweed	0
	wheatgrass	20
	whorled milkweed	0
19	blue grama	0
	downy Brome	5
	goat's beard	0
	white aster	0
	sand dropseed	0
	sun sedge	40
20	downy Brome	5
	sand dropseed	0
	sun sedge	5
21	downy Brome	5
	Kentucky bluegrass	0
	sand dropseed	0
	sun sedge	60
22	downy Brome	0
	Kentucky bluegrass	15
	sun sedge	35
23	downy Brome	20
	prairie sandreed	0
	sand bluestem	0
	virginia groundcherry	0
	western ragweed	0
24	black root	20
	blue grama	0
	downy Brome	10
	moss	75
	needleandthread	0

Appendix A4 continued. Vegetation frequency and percent green-up data.

Mexican Canyon Transect 1 – 5/18/07

Plot #	Plant Name	Green up
1	blackroot	100
	downy brome	100
	goldaster	100
	needleandthread	100
	purple prairieclover	100
2	blackroot	100
	downy brome	100
	peppergrass	100
	needleandthread	100
	puccoon	100
	wheatgrass	100
3	blackroot	100
	downy brome	100
	fringe sagebrush	100
	junegrass	80
	prairie sandreed	75
	puccoon	100
	spiderwort	100
	wheatgrass	100
4	blackroot	100
	death cambas	100
	fringe sagebrush	100
	phlox	100
	junegrass	100
	prairie sandreed	70
	puccoon	100
	Japenese brome	100
	yucca	100
5	fringe sagebrush	100
	junegrass	100
	Kentucky bluegrass	100
	prairie sandreed	30
	primrose	100
	puccoon	100
	scarlet gaura	100
	scarlet globemallow	100
	sun sedge	100
	Japenese brome	100
6	downy brome	100
	scarlet globemallow	100
	sun sedge	100
	wheatgrass	100
7	cudweed sagewort	100
	downy brome	100
	Kentucky bluegrass	100
	little bluestem	100
	puccoon	100
	scarlet globemallow	100
7	sun sedge	100
	Japenese brome	100
8	downy brome	100
	needleandthread	100
	purple vetch	100
	scarlet globemallow	100
	skeleton rush	100
	sun sedge	100
	Japenese brome	100
	western ragweed	0
9	goat's beard	100
	Kentucky bluegrass	100
	prairie sandreed	40
	sun sedge	100
	Japenese brome	100
10	puccoon	100
	scarlet globemallow	100
	sun sedge	100
	Japenese brome	100
	western ragweed	0
	wheatgrass	100
11	downy brome	100
	fringe sagebrush	100
	goat's beard	100
	Rockymountain beeplant	100
	skeleton rush	100
	sun sedge	100
	wheatgrass	100
	yucca	100
12	blackroot	100
	desert stickseed	100
	downy brome	100
	junegrass	100
	needleandthread	100
	Rockymountain beeplant	100
	spiderwort	100
13	blackroot	100
	blue grama	100
	brittle cactus	100
	goldaster	100
	goldenrod	100
	needleandthread	100
	scarlet globemallow	100
14	blackroot	100
	downy brome	100
	needleandthread	100
	scarlet globemallow	100

Appendix A4 continued. Vegetation frequency and percent green-up data.

Mexican Canyon Transect 1 - 5/18/07

Plot #	Plant Name	Green up
16	spiderwort	100
	western ragweed	100
15	downy brome	100
	sand bluestem	100
	scarlet globemallow	100
	smooth brome	100
16	dandelion	100
	downy brome	100
	sand bluestem	100
	scarlet globemallow	100
	smooth brome	100
17	needleandthread	100
	prairie sandreed	100
	scarlet globemallow	100
	sun sedge	100
	wheatgrass	100
18	downy brome	100
	prairie sandreed	100
	smooth brome	100
	sun sedge	100
19	Kentucky bluegrass	100
	sun sedge	100
	wheatgrass	100
20	downy brome	100
	prairie sandreed	100
	scarlet globemallow	100
	Japenese brome	100
	western ragweed	100
21	goldenrod	100
	scarlet globemallow	100
	Japenese brome	100
	western ragweed	100
22	sun sedge	100
	Japenese brome	100
	wheatgrass	100
23	downy brome	100
	Kentucky bluegrass	100
	prairie sandreed	100
	sun sedge	100
24	downy brome	100
	fringe sagebrush	100
	Kentucky bluegrass	100
	purple vetch	100
	Japenese brome	100
25	downy brome	100
	fringe sagebrush	100
	sand bluestem	100

Appendix A4 continued. Vegetation frequency and percent green-up data.

Mexican Canyon Transect 1 - 7/18/07

Plot #	Plant Name	Green up
1	downy brome	0
	hairy goldaster	100
	Japanese brome	0
	needleandthread	0
	purple prairieclover	100
2	blackroot	10
	needleandthread	0
	prairie sandreed	100
	puccoon	100
	scarlet gaura	100
3	blackroot	5
	Japanese brome	0
	needleandthread	0
	western ragweed	100
	white aster	100
	whorled milkweed	100
	wild rose	100
4	blackroot	10
	blue grama	15
	goldenrod	100
	Japanese brome	0
	junegrass	0
	shelleaf penstomon	0
	sideoats grama	60
	skeletonweed	100
	sun sedge	80
	white aster	85
	whorled milkweed	100
	woolly plantain	0
5	Japanese brome	0
	Kentucky bluegrass	0
	needleandthread	5
	prairie sandreed	100
	sun sedge	85
	western ragweed	100
	white aster	100
	woolly plantain	0
6	goat's beard	100
	Japanese brome	0
	Kentucky bluegrass	0
	prairie sandreed	100
	sand bluestem	70
	smooth brome	100
	sun sedge	90
7	blue grama	20
	downy brome	0
	goat's beard	0
	Japanese brome	0
7	needleandthread	0
	sideoats grama	80
	skeletonweed	100
	sun sedge	75
	western ragweed	70
	white aster	95
8	goat's beard	0
	Kentucky bluegrass	0
	prairie sandreed	100
	sun sedge	90
	white aster	100
9	Japanese brome	0
	needleandthread	10
	prairie sandreed	100
	western ragweed	60
	white aster	100
10	downy brome	0
	Japanese brome	0
	needleandthread	15
	skeletonweed	100
	sun sedge	10
	Rockymountian beeplant	100
11	downy brome	0
	fringed sagebrush	100
	needleandthread	0
	peppergrass	0
	sideoats grama	30
	wild rose	10
12	blackroot	15
	blue grama	20
	downy brome	0
	fringed sagebrush	100
	needleandthread	0
	Rockymountian beeplant	100
	western ragweed	100
13	downy brome	0
	fringed sagebrush	100
	sand bluestem	20
	sideoats grama	45
	sun sedge	95
	western ragweed	80
	white aster	100
14	downy brome	0
	sand bluestem	75
	sun sedge	90
15	downy brome	0
	Kentucky bluegrass	0

Appendix A4 continued. Vegetation frequency and percent green-up data.

Mexican Canyon Transect 1 - 7/18/07

Plot #	Plant Name	Green up
15	needleandthread	0
	prairie sandreed	100
	sideoats grama	25
	silverleaf lupine	100
16	downy brome	0
	Japanese brome	0
	needleandthread	15
	prairie sandreed	100
	sand bluestem	60
	sun sedge	80
	western ragweed	100
	wheatgrass	20
17	downy brome	0
	Japanese brome	0
	sand bluestem	50
	sideoats grama	30
	sun sedge	70
	Texas Croton	100
	wheatgrass	10
18	Japanese brome	0
	junegrass	0
	Kentucky bluegrass	0
	needleandthread	0
	sun sedge	85
	western ragweed	100
	white aster	100
19	downy brome	0
	Japanese brome	0
	Kentucky bluegrass	0
	prairie sandreed	95
	Texas Croton	100
	western ragweed	100
20	Japanese brome	0
20	Kentucky bluegrass	0
	needleandthread	0
	prairie sandreed	100
21	Kentucky bluegrass	0
	needleandthread	0
	prairie sandreed	100
	sun sedge	70
	western ragweed	100
22	Japanese brome	0
	junegrass	0
	prairie sandreed	95
	sand bluestem	70
	sun sedge	80
	white aster	100
23	downy brome	0
	fringed sagebrush	100
	Japanese brome	0
	Kentucky bluegrass	0
	skeletonweed	100
	sun sedge	70
24	downy brome	0
	horseweed	100
	Japanese brome	0
	needleandthread	0
	prairie sandreed	100
	western ragweed	100
25	downy brome	0
	Japanese brome	0
	needleandthread	0
	scarlet gaura	100
	wheatgrass	25

Appendix A4 continued. Vegetation frequency and percent green-up data.

Mexican Canyon Transect 1 - 10/16/07

Plot #	Plant Name	Green up
1	blackroot	0
	downy brome	0
	fringed sagebrush	95
	hairy goldaster	35
	needleandthread	5
	sideoats grama	15
2	blackroot	0
	downy brome	0
	needleandthread	0
	sideoats grama	0
	white aster	5
3	blackroot	0
	downy brome	0
	fringed sagebrush	70
	needleandthread	0
	white aster	5
4	blackroot	20
	downy brome	0
	fringed sagebrush	90
	junegrass	0
	little bluestem	15
	prairie sandreed	0
	white aster	10
	yucca	100
5	downy brome	0
	junegrass	0
	prairie sandreed	5
	western ragweed	10
	white aster	0
6	Kentucky bluegrass	0
	needleandthread	0
	smooth brome	35
	sun sedge	40
7	downy brome	0
	fringed sagebrush	90
	Kentucky bluegrass	0
	needleandthread	0
	sand dropseed	15
	western ragweed	5
8	downy brome	0
	Kentucky bluegrass	0
	needleandthread	0
	sand dropseed	10
	sun sedge	25
	western ragweed	0
	wheatgrass	15
9	smooth brome	40
	sun sedge	30
	western ragweed	85
10	downy brome	0
	needleandthread	0
	prairie sandreed	20
	sand dropseed	5
11	downy brome	0
	fringed sagebrush	30
	needleandthread	0
	skeleton weed	80
	wheatgrass	15
12	downy brome	0
	fringed sagebrush	60
	needleandthread	5
	sideoats grama	5
	wild rose	0
13	blackroot	0
	downy brome	0
	pricklypear cactus	40
	skeleton weed	70
	western ragweed	65
14	downy brome	0
	junegrass	0
	needleandthread	0
	sand bluestem	0
	white aster	30
15	downy brome	0
	prairie sandreed	90
	pricklypear cactus	100
	sun sedge	20
	western ragweed	70
16	downy brome	0
	needleandthread	0
	prairie sandreed	65
17	prairie sandreed	80
	sun sedge	25
	western ragweed	80
18	Kentucky bluegrass	0
	sun sedge	40
	wheatgrass	60
19	sand bluestem	0
	smooth brome	30
	western ragweed	10
	wheatgrass	50
20	downy brome	0
	Texas croton	10
	western ragweed	40
21	downy brome	0
	needleandthread	0
	prairie sandreed	60

Appendix A4 continued. Vegetation frequency and percent green-up data.

Mexican Canyon Transect 1 - 10/16/07

Plot #	Plant Name	Green up
21	sun sedge	30
	wheatgrass	25
22	downy brome	0
	Kentucky bluegrass	0
	needleandthread	0
	prairie sandreed	40
	sun sedge	45
23	hairy goldaster	20
	Kentucky bluegrass	0
	needleandthread	0
	prairie sandreed	35
	sand bluestem	0
	sun sedge	40
	white aster	25
24	downy brome	0
	prairie sandreed	45
	sun sedge	10
25	downy brome	0
	prairie sandreed	5

Appendix A4 continued. Vegetation frequency and percent green-up data.

Mexican Canyon Transect 2 - 3/6/07

Plot #	Slope	Plant	Green up
1	South	hairy goldaster	100
		sideoats grama	5
		wheatgrass	15
2	South	plains mughly	0
		sand bluestem	0
		sideoats grama	0
3	South	blue grama	0
		little bluestem	0
		sideoats grama	0
4	South	fringe sagebrush	50
		gayfeather	0
		needleandthread	0
		white aster	0
		sun sedge	40
5	North	fringe sagebrush	25
		white aster	0
		unknown forb 1	5
6	North	downy brome	60
		fringe sagebrush	80
		needleandthread	0
		prairie sandreed	0
		sideoats grama	0
		wheatgrass	65
7	North	fringe sagebrush	35
		smooth brome	0
		unknown forb 1	10
8	North	hairy goldaster	0
		junegrass	5
		moss	65
		skunkbrush sumac	0
		sun sedge	30
		unknown forb 2	40
9	Drainage	chokecherry	0
		goldenrod	0
		white aster	0
		snowberry	0
		sun sedge	15
		wild rose	0
10	Drainage	chokecherry	0
		downy brome	90
		gayfeather	100
		Kentucky bluegrass	85
		white aster	0
10		sideoats grama	0
	Drainage	sun sedge	40
11	South	downy brome	70
		needleandthread	0
		plains mughly	0
		sideoats grama	0
12	South	downy brome	70
		plains mughly	0
		sideoats grama	0
		wheatgrass	60
13	South	dandelion	100
		downy brome	0
		needleandthread	0
		sideoats grama	0
14	South	downy brome	0
		sideoats grama	0
15	North	cudweed sagewort	0
		Kentucky bluegrass	0
		white aster	0
		sun sedge	30
		yucca	95
16	North	chokecherry	0
		cudweed sagewort	0
		goldenrod	0
		sun sedge	15
17	North	little bluestem	0
		needleandthread	0
		sun sedge	5
		unknown forb 2	60
18	North	goldenrod	0
		goldenrod	0
		moss	70
		sun sedge	20
19	Drainage	cudweed sagewort	0
		Kentucky bluegrass	0
		needleandthread	0
		sun sedge	20
20	North	crazyweed	100
		fringe sagebrush	80
		moss	80
		prairie sandreed	0
		yucca	95

Appendix A4 continued. Vegetation frequency and percent green-up data.

Mexican Canyon Transect 2 – 5/18/07

Plot #	Slope	Plant	Green up
1	North	blackroot	100
		fringe sagebrush	100
		Japanese brome	100
		purple vetch	100
		Rockymountain beeplant	100
		textile onion	100
2	Drainage	goat’s beard	100
		Japanese brome	100
		Kentucky bluegrass	100
		wheatgrass	100
3	North	goat’s beard	100
		poison Ivy	100
		Rockymountain beeplant	100
		sun sedge	100
		wheatgrass	100
4	North	rockcress	100
		blue-eyed grass	100
		goat’s beard	100
		wheatgrass	100
		white aster	0
5	North	goat’s beard	100
		Kentucky bluegrass	100
		lambstongue groundsel	100
		puccoon	100
		wheatgrass	100
6	North	cudweed sagewort	100
		goldenpea	100
		puccoon	100
		snowberry	100
		sun sedge	100
		western ragweed	0
		wheatgrass	100
		wild rose	100
7	North	rockcress	100
		cudweed sagewort	100
		prairie chickweed	100
		puccoon	100
		sun sedge	100
		western ragweed	0
		white aster	40
8	South	blackroot	100
		fringe sagebrush	100
		goldenpea	100
		purple vetch	100
8	South	skeleton rush	100
		spiderwort	100
		textile onion	100
		wheatgrass	100
9	South	blackroot	100
		downy brome	100
		puccoon	100
		sideoats grama	100
		skunkbrush sumac	100
		smooth brome	100
		spiderwort	100
10	South	desert stickseed	100
		downy brome	100
		goat's beard	100
		peppergrass	100
		pricklypear cactus	100
		textile onion	100
		wheatgrass	100
11	South	blackroot	100
		desert stickseed	100
		downy brome	100
		skunkbrush sumac	100
		wheatgrass	100
12	South	desert stickseed	100
		needleandthread	100
		purple vetch	100
		scarlet gaura	100
		sego lily	100
		sideoats grama	100
13	South	desert stickseed	100
		needleandthread	100
		peppergrass	100
		sideoats grama	100
		white beardstongue	100
14	Drainage	chokecherry	100
		goat's beard	100
		Kentucky bluegrass	100
		poison Ivy	100
		prairie chickweed	100
15	Drainage	chokecherry	100
		dandelion	100
		fringe sagebrush	100
		goldenpea	100
		Kentucky bluegrass	100

Appendix A4 continued. Vegetation frequency and percent green-up data.

Mexican Canyon Transect 2 - 5/18/07

Plot #	Slope	Plant	Green up
15	Drainage	prairie chickweed	100
16	Drainage	rockcress	100
		goldenpea	100
		horseweed	100
		sun sedge	100
17	North	downy brome	100
		fringe sagebrush	100
		goat's beard	100
		Kentucky bluegrass	100
		prairie chickweed	100
		Rockymountain beeplant	100
		sun sedge	100
		crazyweed	100
18	North	chokecherry	100
		fringe sagebrush	100
		goat's beard	100
		Japanese brome	100
		Kentucky bluegrass	100
		puccoon	100
		skeleton rush	100
		crazyweed	100
19	South	cudweed sagewort	100
		desert stickseed	100
		downy brome	100
		junegrass	100
		sideoats grama	100
		sun sedge	100
20	North	chokecherry	100
		goat's beard	100
20	North	Kentucky bluegrass	100
		white aster	0
21	North	fringe sagebrush	40
		Kentucky bluegrass	100
		sun sedge	100
22	South	blackroot	100
		desert stickseed	100
		downy brome	100
		fringe sagebrush	100
		peppergrass	100
		Rockymountain beeplant	100
		textile onion	100
		wheatgrass	100
23	South	desert stickseed	100
		downy brome	100
		fringe sagebrush	100
		Rockymountain beeplant	100
		sideoats grama	100
		western wallflower	100
24	South	desert stickseed	100
		downy brome	100
		sideoats grama	100
25	South	needleandthread	100
		purple vetch	100
		Rockymountain beeplant	100
		scarlet gaura	100

Appendix A4 continued. Vegetation frequency and percent green-up data.

Mexican Canyon Transect 2 – 7/18/07

Plot #	Slope	Plant	Green up
1	South	desert stickseed	0
		downy brome	0
		fringed sagebrush	100
		tumble mustard	0
		Rockymountain beeplant	15
2	South	blackroot	40
		downy brome	0
		sand bluestem	40
		sand dropseed	50
		tumble mustard	0
3	South	downy brome	0
		Japanese brome	0
		plains mughly	100
		sideoats grama	90
4	South	downy brome	0
		scarlet gaura	100
		sideoats grama	80
5	North	sun sedge	95
		white aster	90
		yucca	100
6	North	chokecherry	100
		sun sedge	80
		wheatgrass	30
7	South	cudweed sagewort	100
		downy brome	0
		Japanese brome	0
		needleandthread	5
		prairie sandreed	95
		sideoats grama	40
		sun sedge	100
		Rockymountain beeplant	0
8	North	chokecherry	100
		fringed sagebrush	100
		golden pea	85
		Japanese brome	0
		Kentucky bluegrass	0
		wheatgrass	30
9	North	golden pea	70
		goldenrod	100
		groundsol	10
		hare bell	60
		junegrass	0
		puccoon	60
9	North	snowberry	0
		field chickweed	0
		wheatgrass	25
10	North	blackroot	40
		golden pea	40
		junegrass	0
		needleandthread	0
		poison ivy	100
		silverleaf pladderpod	0
		field chickweed	0
		scarlet gaura	100
		wheatgrass	15
11	North	golden pea	70
		goldenrod	100
		sun sedge	90
		white aster	90
		wild rose	100
12	Drainage	golden pea	60
		hairy goldaster	100
		needleandthread	5
		puccoon	100
		sun sedge	65
		wheatgrass	15
		white aster	100
		wild rose	100
13	Drainage	Kentucky bluegrass	0
		poison ivy	100
		snowberry	40
		field chickweed	0
		wheatgrass	30
		wild rose	90
14	South	blackroot	20
		downy brome	0
		golden pea	30
		Kentucky bluegrass	0
		needleandthread	5
		pricklypear cactus	95
		skunkbrush sumac	100
15	South	downy brome	0
		needleandthread	10
		prairie sandreed	100
		purple prairieclover	100
		sideoats grama	55
		Rockymountain beeplant	15

Appendix A4 continued. Vegetation frequency and percent green-up data.

Mexican Canyon Transect 2 - 7/18/07

Plot #	Slope	Plant	Green up
16	South	blackroot	5
		desert stickseed	0
		downy brome	0
		golden pea	25
		Japanese brome	0
		poison ivy	100
		sideoats grama	30
		Rockymountain beeplant	100
17	South	downy brome	0
		golden pea	70
		sideoats grama	80
		tumble mustard	0
		wheatgrass	0
18	South	desert stickseed	0
		downy brome	0
		Japanese brome	0
		sideoats grama	70
		skunkbrush sumac	100
		scarlet gaura	100
19	North	fringed sagebrush	100
		goldenrod	80
		junegrass	5
		needleandthread	0
		phlox	10
		sun sedge	65
		field chickweed	0
		Rockymountain beeplant	100
		white aster	100
20	North	chokecherry	100
		cudweed sagewort	100
		goldenrod	100
20	North	poison ivy	100
		prairie sandreed	100
		sun sedge	95
		field chickweed	0
		white aster	100
21	North	golden pea	60
		Kentucky bluegrass	0
		snowberry	95
		sun sedge	75
		white aster	100
		wild rose	100
22	North	Kentucky bluegrass	0
		prairie sandreed	85
		sun sedge	80
		Rockymountain beeplant	100
		white aster	100
23	North	goldenrod	100
		prairie sandreed	95
		sun sedge	90
		white aster	100
24	Drainage	bergamat	80
		cudweed sagewort	100
		Kentucky bluegrass	0
		prairie sandreed	100
		sun sedge	100
25	South	blackroot	5
		fringed sagebrush	100
		gayfeather	100
		sand bluestem	70
		white aster	100

Appendix A4 continued. Vegetation frequency and percent green-up data.

Mexican Canyon Transect 2 - 10/16/07

Plot #	Slope	Plant	Green up
1	South	cudweed sagewort	0
		downy brome	0
		fringed sagebrush	35
		needleandthread	0
		sun sedge	0
2	South	blackroot	5
		downy brome	0
		needleandthread	5
		sand bluestem	10
3	South	blue grama	15
		cudweed sagewort	0
		needleandthread	0
		sand bluestem	40
4	North	fringed sagebrush	60
		needleandthread	0
		prairie milkvetch	85
		sun sedge	15
		white aster	15
		yucca	100
5	North	chokecherry	0
		goldenrod	15
		wheatgrass	20
		white aster	5
6	South	chokecherry	0
		downy brome	0
		sideoats grama	40
		sun sedge	0
		tumble mustard	0
7	North	broom snakeweed	100
		downy brome	0
		fringed sagebrush	80
		scarlet guara	10
		wheatgrass	20
		yucca	100
8	North	fringed sagebrush	95
		goldenrod	15
		prairie milkvetch	90
		skunkbrush sumac	0
		snowberry	0
		wheatgrass	10
		white aster	0
		wild rose	5
9	Drainage	chokecherry	0
		hairy goldaster	0
		junegrass	0
		sun sedge	15
9	Drainage	wheatgrass	10
		white aster	0
10	Drainage	field chickweed	0
		goldenrod	15
		Kentucky bluegrass	70
		rockcress	100
		snowberry	5
		white aster	0
11	South	desert stickseed	0
		fringed sagebrush	85
		skunkbrush sumac	20
		tumble mustard	0
		western ragweed	0
		wheatgrass	0
12	South	blackroot	0
		downy brome	0
		needleandthread	10
		scarlet guara	0
		sideoats grama	35
		wheatgrass	10
13	South	cudweed sagewort	15
		downy brome	0
		needleandthread	0
		sideoats grama	40
		snowberry	5
		wheatgrass	15
14	South	desert stickseed	0
		downy brome	0
		poison ivy	25
		sideoats grama	20
		skunkbrush sumac	15
		snowberry	80
15	South	downy brome	0
		fringed sagebrush	25
		sideoats grama	30
		wheatgrass	0
16	South	fringed sagebrush	0
		scarlet guara	0
		sideoats grama	15
		wheatgrass	0
		yucca	100
17	North	field chickweed	0
		fringed sagebrush	100
		needleandthread	0
		skeleton weed	100
		sun sedge	60

Appendix A4 continued. Vegetation frequency and percent green-up data.

Mexican Canyon Transect 2 – 10/16/07

Plot #	Slope	Plant	Green up
17	North	white aster	15
18	North	chokecherry	0
		cudweed sagewort	0
		goldenrod	90
		sun sedge	15
		wheatgrass	10
		white aster	5
19	North	smooth brome	5
		snowberry	20
		sun sedge	40
		western ragweed	10
20	North	Kentucky bluegrass	0
		sun sedge	55
21	North	goldenrod	20
		hairy goldaster	5
		sun sedge	30
22	North	broom snakeweed	95
		goldenrod	75
		hairy goldaster	0
		needleandthread	5
		sun sedge	15
		white aster	15
23	North	chokecherry	0
		fringed sagebrush	90
		hairy goldaster	0
		needleandthread	5
		sun sedge	25
		white aster	5
24	Drainage	Kentucky bluegrass	0
		sun sedge	35
		wheatgrass	70
		white aster	15
25	South	broom snakeweed	15
		downy brome	0
		fringed sagebrush	80
		goldenrod	0
		junegrass	0
		prairie sandreed	0
		white aster	0

Appendix A4 continued. Vegetation frequency and percent green-up data.

Smiley Canyon Transect 1 – 3/6/07

Plot #	Plant Name	Green up
1	american licorice	0
	blue grama	30
	dotted gayfeather	0
	downy brome	0
	fringe sagebrush	60
	junegrass	10
	needleandthread	0
2	american licorice	0
	blackroot	15
	downy brome	40
	needleandthread	0
3	fringe sagebrush	20
	Kentucky bluegrass	15
	sideoats grama	0
	yucca	70
4	Kentucky bluegrass	10
	prairie sandreed	0
	sand bluestem	0
	western ragweed	0
	yucca	100
5	blackroot	35
	junegrass	20
	little bluestem	0
	moss	100
	needleandthread	0
	yucca	100
6	junegrass	10
	Kentucky bluegrass	10
	little bluestem	0
	moss	100
	prairie sandreed	0
	sideoats grama	0
7	needleandthread	0
	white aster	0
	prairie sandreed	0
	sun sedge	25
8	goat's beard	0
	hairy goldaster	100
	white aster	0
	smooth brome	0
	sun sedge	15
9	goldenrod	0
	Kentucky bluegrass	5
	smooth brome	0
10	canadian thistle	0
	Kentucky bluegrass	10
	white aster	0
	Prairie thermopsis	0
10	sun sedge	45
11	canadian thistle	0
	Kentucky bluegrass	10
	western ragweed	0
12	downy brome	40
	hairy goldaster	0
	moss	65
	western ragweed	0
	wheatgrass	0
13	smooth brome	0
14	junegrass	5
	Kentucky bluegrass	5
	moss	95
	needleandthread	0
	white aster	0
	smooth brome	0
	sun sedge	50
15	white aster	15
	Prairie thermopsis	0
	smooth brome	0
	snowberry	0
	sun sedge	20
	unknown forb 4	0
	yucca	100
16	fringe sagebrush	5
	moss	100
	needleandthread	0
	Prairie thermopsis	0
	skeleton rush	0
17	blackroot	10
	fringe sagebrush	10
	moss	100
	Oenothera spp.	100
	phlox.	40
	white aster	10
	Prairie thermopsis	0
	smooth brome	0
18	Kentucky bluegrass	5
	Prairie thermopsis	0
	wheatgrass	5
	yucca	60
19	Kentucky bluegrass	10
	little bluestem	0
	prairie sandreed	0
20	goat's beard	0
	needleandthread	0
	skeleton rush	0
	sun sedge	60

Appendix A4 continued. Vegetation frequency and percent green-up data.

Smiley Canyon Transect 1 – 5/18/07

Plot #	Plant Name	Green up
1	little bluestem	30
	puccoon	100
	skeleton rush	100
	sun sedge	100
	textile onion	100
	goat's beard	100
	wheatgrass	100
2	Kentucky bluegrass	100
	western ragweed	0
	wheatgrass	100
3	goldenpea	100
	Kentucky bluegrass	100
	smooth brome	100
4	harebell	100
	fringe sagebrush	100
	goldenpea	100
	spiderwort	100
	wheatgrass	100
5	yarrow	100
	smooth brome	70
	sun sedge	100
6	goldenpea	100
	smooth brome	80
	snowberry	100
	sun sedge	100
7	puccoon	100
	smooth brome	60
	sun sedge	100
8	junegrass	100
	little bluestem	15
	puccoon	100
	smooth brome	95
9	Kentucky bluegrass	100
	smooth brome	100
	thistle	100
10	dandelion	100
	Kentucky bluegrass	100
11	dandelion	100
	Kentucky bluegrass	100
	puccoon	100
	sun sedge	100
	wheatgrass	100
12	smooth brome	100
	sun sedge	100
13	Kentucky bluegrass	100
	smooth brome	100
	wheatgrass	100
14	silverleaf scufpea	100
	Kentucky bluegrass	100
14	little bluestem	40
	puccoon	100
	sand bluestem	0
	scarlet globemallow	100
	sun sedge	100
	wheatgrass	100
15	silverleaf scufpea	100
	downy brome	100
	junegrass	100
	Kentucky bluegrass	100
	little bluestem	10
	prairie sandreed	0
	scarlet globemallow	100
	silvery lupine	100
	sun sedge	100
	western ragweed	0
16	silverleaf scufpea	100
	fringe sagebrush	100
	Kentucky bluegrass	100
	little bluestem	30
	puccoon	100
	sun sedge	100
	goat's beard	100
17	desert stickseed	100
	downy brome	100
	Kentucky bluegrass	100
	scarlet globemallow	100
	spiderwort	100
	western ragweed	0
	wheatgrass	100
18	American licorice	100
	blackroot	100
	desert stickseed	100
	Kentucky bluegrass	100
	sun sedge	100
	goat's beard	100
	wheatgrass	100
19	purple prairieclover	100
	blackroot	100
	desert stickseed	100
	downy brome	100
	needleandthread	100
	Japenese brome	100
	western ragweed	0
	wheatgrass	100
20	blackroot	100
	blue grama	45
	brittle cactus	100
	desert stickseed	100
	downy brome	100
	fringe sagebrush	100

Appendix A4 continued. Vegetation frequency and percent green-up data.

Smiley Canyon Transect 1 – 5/18/07

Plot #	Plant Name	Green up
20	junegrass	40
	phlox	100
	sixweeks fescue	100
	peppergrass	100

Appendix A4 continued. Vegetation frequency and percent green-up data.

Smiley Canyon Transect 1 – 7/18/07

Plot #	Plant Name	Green up
1	blackroot	5
	blue grama	10
	brittle cactus	100
	downy brome	0
	fringed sagebrush	100
	gayfeather	100
	junegrass	0
	needleandthread	0
	peppergrass	0
	sixweeks fescue	0
2	American Licorice	80
	blackroot	0
	downy brome	0
	fringed sagebrush	100
	needleandthread	0
	peppergrass	0
	prairie sandreed	95
	puccoon	100
	silverleaf scurfpea	0
3	downy brome	0
	fringed sagebrush	100
	junegrass	0
	puccoon	100
	scarlet gaura	100
	skeletonweed	100
	wheatgrass	40
4	junegrass	5
	Kentucky bluegrass	0
	little bluestem	35
	needleandthread	10
	prairie sandreed	100
	silverleaf scurfpea	0
	sun sedge	95
	wheatgrass	30
5	downy brome	0
	peppergrass	0
	silverleaf lupine	100
	western ragweed	0
	wheatgrass	35
6	junegrass	0
	Kentucky bluegrass	0
	little bluestem	40
	prairie sandreed	100
	sand bluestem	10
	sun sedge	90
7	smooth brome	70
8	goldenrod	95
	Kentucky bluegrass	0
	prairie sandreed	100
8	smooth brome	80
	sun sedge	80
	western ragweed	95
	white aster	90
9	field chickweed	0
	junegrass	0
	needleandthread	0
	prairie sandreed	100
	puccoon	100
	sun sedge	90
	white aster	100
10	goat's beard	0
	Kentucky bluegrass	0
	prairie sandreed	95
	sun sedge	85
11	smooth brome	70
	western ragweed	85
12	field chickweed	100
	fringed sagebrush	100
	needleandthread	15
	rockcress	0
	scarlet gaura	100
	smooth brome	55
	white aster	100
13	goldenrod	100
	smooth brome	65
	sun sedge	95
	white aster	100
14	field chickweed	0
	golden pea	30
	junegrass	0
	needleandthread	5
	sun sedge	80
	white aster	90
15	fringed sagebrush	100
	goat's beard	0
	golden pea	20
	junegrass	0
	Kentucky bluegrass	0
	needleandthread	0
	skeletonweed	100
	sun sedge	70
	wheatgrass	20
16	fringed sagebrush	100
	gayfeather	100
	golden pea	10
	smooth brome	15
	sun sedge	35
17	golden pea	70
	Kentucky bluegrass	0

Appendix A4 continued. Vegetation frequency and percent green-up data.

Smiley Canyon Transect 1 – 7/18/07

Plot #	Plant Name	Green up
17	needleandthread	0
	prairie sandreed	80
18	fringed sagebrush	100
	Kentucky bluegrass	0
	prairie sandreed	100
19	junegrass	0
	little bluestem	50
	needleandthread	0
	skeletonweed	100
	sun sedge	60
20	Kentucky bluegrass	0
	little bluestem	40
	prairie sandreed	100

Appendix A4 continued. Vegetation frequency and percent green-up data.

Smiley Canyon Transect 1 – 10/17/07

Plot #	Plant Name	Green up
1	American licorice	50
	blackroot	35
	dotted gayfeather	65
	fringed sagebrush	100
	junegrass	0
	pricklypear cactus	100
	sixweeks fescue	0
	wheatgrass	40
2	American licorice	85
	blackroot	20
	blue grama	25
	fringed sagebrush	100
	junegrass	0
	needleandthread	15
	peppergrass	0
3	blackroot	30
	fringed sagebrush	85
	needleandthread	20
	yucca	100
4	junegrass	0
	Kentucky bluegrass	0
	sand bluestem	0
	sun sedge	30
	western ragweed	50
	white aster	45
5	downy brome	0
	peppergrass	0
	prairie sandreed	65
	wheatgrass	35
6	blue grama	10
	junegrass	0
	needleandthread	20
	sand bluestem	0
	sun sedge	35
	wheatgrass	15
7	smooth brome	25
8	smooth brome	35
	sun sedge	30
	western ragweed	40
	white aster	70
9	Kentucky bluegrass	0
	needleandthread	10
	prairie sandreed	20
	wheatgrass	35
10	canadian thistle	0
	downy brome	0
	Kentucky bluegrass	0
	smooth brome	40
11	canadian thistle	65
	Kentucky bluegrass	0
	sun sedge	60
	western ragweed	0
	wheatgrass	45
	white aster	85
12	hairy goldaster	90
	smooth brome	20
13	smooth brome	15
	sun sedge	30
	white aster	25
14	field chickweed	0
	fringed sagebrush	90
	needleandthread	10
	snowberry	15
	sun sedge	15
15	Kentucky bluegrass	0
	needleandthread	0
	skeletonweed	0
	sun sedge	25
	wheatgrass	10
16	downy brome	0
	Kentucky bluegrass	20
	sun sedge	45
17	Kentucky bluegrass	5
	little bluestem	0
	prairie sandreed	5
	smooth brome	30
	sun sedge	35
18	little bluestem	0
	needleandthread	10
	skeletonweed	0
	sun sedge	40
	white aster	75
19	goat's beard	75
	needleandthread	40
	prairie sandreed	0
	skeletonweed	0
	sun sedge	10
20	Kentucky bluegrass	20
	little bluestem	0
	needleandthread	5
	sun sedge	35

Appendix A4 continued. Vegetation frequency and percent green-up data.

Smiley Canyon Transect 2 – 3/6/07

Plot #	Plant Name	Green up
1	downy brome	90
	fringe sagebrush	40
	hairy goldaster	0
	white aster	0
	Prairie thermopsis	0
	skunkbrush sumac	0
	smooth brome	10
2	American licorice	0
	crazyweed	100
	fringe sagebrush	70
	hairy goldaster	30
	snowberry	0
	unknown forb 4	0
	wheatgrass	5
3	Kentucky bluegrass	0
	Prairie thermopsis	0
	sun sedge	60
4	American licorice	0
	fringe sagebrush	40
	goldenrod	0
	hairy goldaster	0
	Kentucky bluegrass	0
	needleandthread	0
	white aster	0
	Prairie thermopsis	0
5	false bonaset	0
	Kentucky bluegrass	0
	white aster	0
	sideoats grama	0
	yucca	100
6	dotted gayfeather	0
	junegrass	10
	little bluestem	0
	needleandthread	0
	sideoats grama	0
	sun sedge	35
7	Kentucky bluegrass	0
	white aster	0
	smooth brome	0
	sun sedge	30
8	goldenrod	0
	goldenrod	0
	hairy goldaster	0
	Kentucky bluegrass	0
8	western ragweed	0
9	goldenrod	0
	hairy goldaster	40
	Kentucky bluegrass	0
	moss	80
	white aster	40
	Prairie thermopsis	0
	unknown forb 5	0
10	fringe sagebrush	20
	moss	90
	white aster	50
	Prairie thermopsis	0
	smooth brome	0
	sun sedge	20
11	downy brome	0
	needleandthread	0
	white aster	0
	sun sedge	70
12	Kentucky bluegrass	0
	snowberry	0
13	goldenrod	0
	hairy goldaster	0
	Kentucky bluegrass	0
	moss	100
	white aster	25
	sun sedge	30
14	fringe sagebrush	5
	goldenrod	0
	goldenrod	0
	hairy goldaster	0
	white aster	25
	sideoats grama	0
	snowberry	0
15	hairy goldaster	0
	needleandthread	0
	Prairie thermopsis	0
	sun sedge	45
16	hairy goldaster	0
	Kentucky bluegrass	0
	moss	100
	prairie sandreed	0
	Prairie thermopsis	0
	snowberry	0
	unknown forb 6	0
17	fringe sagebrush	20
	hairy goldaster	0

Appendix A4 continued. Vegetation frequency and percent green-up data.

Smiley Canyon Transect 2 – 3/6/07

Plot #	Plant Name	Green up
17	needleandthread	0
	white aster	0
	Prairie thermopsis	0
	sun sedge	60
	yucca	90
18	hairy goldaster	0
	moss	100
	white aster	35
	prairie sandreed	0
	Prairie thermopsis	0
	unknown forb 7	0
19	fringe sagebrush	40
	hairy goldaster	0
	needleandthread	0
	Oenothera spp.	100
	white aster	0
	silverleaf bladderpod	0
	sun sedge	15
	yucca	90
20	blackroot	15
	false boneset	100
	fringe sagebrush	40
	junegrass	0
	white aster	40

Appendix A4 continued. Vegetation frequency and percent green-up data.

Smiley Canyon Transect 2 – 5/18/07

Plot #	Plant Name	Green up
1	harebell	100
	dandelion	100
	fringe sagebrush	100
	goldenpea	100
	white aster	0
	puccoon	100
	smooth brome	100
	wheatgrass	100
2	goldenpea	100
	Kentucky bluegrass	100
	pasque flower	100
	prairie chickweed	100
	puccoon	100
	snowberry	100
	wheatgrass	100
	wild rose	100
3	goldenpea	100
	Kentucky bluegrass	100
4	goat's beard	100
	fringe sagebrush	100
	goldenpea	100
	junegrass	60
	puccoon	100
	smooth brome	100
	sun sedge	100
	western ragweed	0
5	blackroot	100
	downy brome	100
	fringe sagebrush	100
	goldenpea	100
	pricklypear cactus	100
	spiderwort	100
	wheatgrass	100
6	blackroot	100
	little bluestem	0
	needleandthread	40
	puccoon	100
	sun sedge	100
7	goat's beard	100
	goldenrod	0
	puccoon	100
	sun sedge	100
8	harebell	100
	goat's beard	100
	goldenpea	100
	puccoon	100
	smooth brome	100
8	sun sedge	100
9	goat's beard	100
	goldenpea	100
	prairie chickweed	100
	smooth brome	100
	snowberry	100
	yucca	100
10	goat's beard	100
	goldenpea	100
	prairie chickweed	100
	puccoon	100
	sun sedge	100
	western ragweed	0
	wheatgrass	100
11	goldenpea	100
	ground plum	100
	Kentucky bluegrass	100
	puccoon	100
	sun sedge	100
12	harebell	100
	goat's beard	100
	goldenpea	100
	prairie chickweed	100
	smooth brome	100
	snowberry	100
13	goat's beard	100
	prairie chickweed	100
	smooth brome	100
	snowberry	100
14	blackroot	100
	fringe sagebrush	100
	goldenpea	100
	prairie chickweed	100
	puccoon	100
	western ragweed	0
	wheatgrass	100
15	goldenpea	100
	poison ivy	100
	puccoon	100
	sun sedge	100
	western ragweed	0
	wheatgrass	100
	annual mustard	100
16	goldenpea	100
	poison ivy	100
	prairie chickweed	100
	puccoon	100
	sun sedge	100
	yucca	100

Appendix A4 continued. Vegetation frequency and percent green-up data.

Smiley Canyon Transect 2 – 5/18/07

Plot #	Plant Name	Green up
17	junegrass	85
	Kentucky bluegrass	100
	puccoon	100
	purple vetch	100
	sun sedge	100
	peppergrass	100
	wheatgrass	100
	wheatgrass	100
18	harebell	100
	goat's beard	100
	blackroot	100
	fringe sagebrush	100
	white aster	0
	poison ivy	100
	puccoon	100
	sun sedge	100
19	goldenpea	100
	puccoon	100
	purple vetch	100
	sun sedge	100
	wheatgrass	100
20	rockcress	100
	white aster	0
	needleandthread	100
	prairie chickweed	100
	puccoon	100
	purple vetch	100
	sun sedge	100
	crazyweed	100
	yucca	100

Appendix A4 continued. Vegetation frequency and percent green-up data.

Smiley Canyon Transect 2 – 7/18/07

Plot #	Plant Name	Green up
1	goldenrod	100
	hairy goldaster	100
	needleandthread	0
	rockcress	30
	Rockymountain beeplant	100
	white aster	80
2	fringed sagebrush	100
	goldenpea	55
	hairy goldaster	100
	needleandthread	5
	sun sedge	60
	field chickweed	0
	white aster	100
	yucca	100
3	blackroot	40
	fringed sagebrush	100
	goldenpea	15
	hairy goldaster	100
	needleandthread	0
	sun sedge	50
	white aster	30
4	fringed sagebrush	100
	goldenpea	10
	hairy goldaster	100
	harebell	90
	Kentucky bluegrass	0
	sixweeks fescue	0
	sun sedge	65
	Rockymountain beeplant	100
	wheatgrass	5
	white aster	60
	yucca	100
5	blackroot	40
	goldenpea	75
	junegrass	0
	sun sedge	40
	field chickweed	0
	white aster	90
6	fringed sagebrush	100
	goldenpea	90
	goldenrod	100
	junegrass	0
	needleandthread	0
	field chickweed	0
	white aster	0
	wild rose	0
7	fringed sagebrush	100
	goldenrod	100
7	harebell	90
	junegrass	0
	needleandthread	0
	snowberry	85
	white aster	100
8	goldenrod	100
	harebell	75
	needleandthread	5
	sun sedge	70
	field chickweed	0
	white aster	90
9	Kentucky bluegrass	0
	snowberry	80
	sun sedge	70
	field chickweed	0
	white aster	30
10	goldenpea	90
	goldenrod	100
	needleandthread	10
	poison ivy	100
	smooth brome	90
	white aster	20
11	gayfeather	100
	goldenpea	40
	goldenrod	100
	needleandthread	0
	smooth brome	40
	sun sedge	65
	field chickweed	0
	white aster	95
12	goldenrod	100
	harebell	80
	smooth brome	30
	snowberry	60
	white aster	40
13	goldenpea	5
	goldenrod	100
	junegrass	0
	sun sedge	80
	white aster	100
	yucca	100
14	goldenrod	100
	western ragweed	0
	wheatgrass	15
	white aster	100
15	fringed sagebrush	100
	goldenrod	100
	hairy goldaster	100
	needleandthread	0

Appendix A4 continued. Vegetation frequency and percent green-up data.

Smiley Canyon Transect 2 – 7/18/07

Plot #	Plant Name	Green up
15	sun sedge	40
	white aster	80
16	goldenpea	80
	goldenrod	100
	hairy goldaster	100
	junegrass	0
	needleandthread	0
	white aster	100
17	goldenpea	80
	goldenrod	100
	hairy goldaster	100
	junegrass	0
	needleandthread	0
	white aster	100
18	goldenpea	50
	sun sedge	65
	wheatgrass	10
19	goldenpea	80
	goldenrod	100
	snowberry	80
	sun sedge	90
	wheatgrass	10
20	curlycup gumweed	100
	downy brome	0
	fringed sagebrush	100
	goldenpea	90
	hairy goldaster	100
	harebell	60
	skunkbrush sumac	100
	wheatgrass	30

Appendix A4 continued. Vegetation frequency and percent green-up data.

Smiley Canyon Transect 2 – 10/17/07

Plot #	Plant Name	Green up
1	goldenrod	20
	hairy goldaster	40
	harebell	0
	needleandthread	0
	wheatgrass	25
2	broom snakeweed	90
	hairy goldaster	50
	needleandthread	5
	snowberry	5
	sun sedge	30
3	downy brome	0
	fringed sagebrush	70
	goldenrod	55
	harebell	0
	sun sedge	30
	white aster	30
4	field chickweed	0
	fringed sagebrush	75
	needleandthread	15
	snowberry	30
	sun sedge	25
5	field chickweed	0
	fringed sagebrush	70
	prairie sandreed	15
	snowberry	0
	wheatgrass	30
6	field chickweed	0
	fringed sagebrush	60
	junegrass	0
	smooth brome	30
	white aster	60
7	goldenrod	0
	smooth brome	35
	sun sedge	35
8	field chickweed	0
	goldenrod	15
	hairy goldaster	85
	harebell	0
	prairie sandreed	30
	snowberry	0
	white aster	75
9	field chickweed	0
	needleandthread	0
	smooth brome	15
	snowberry	0
	sun sedge	40
	wheatgrass	30
10	fringed sagebrush	95
	goldenrod	25
10	hairy goldaster	75
	needleandthread	10
	snowberry	0
	wheatgrass	25
	white aster	75
11	field chickweed	0
	hairy goldaster	65
	smooth brome	25
	snowberry	10
	white aster	25
12	field chickweed	0
	goldenrod	10
	sun sedge	30
	wheatgrass	20
13	goldenrod	0
	smooth brome	10
	sun sedge	55
14	blackroot	15
	broom snakeweed	60
	needleandthread	5
	white aster	80
15	broom snakeweed	75
	dotted gayfeather	0
	false boneset	0
	fringed sagebrush	80
	hairy goldaster	75
	sun sedge	25
	white aster	85
16	hairy goldaster	90
	smooth brome	35
	snowberry	0
	sun sedge	15
17	fringed sagebrush	50
	hairy goldaster	35
	smooth brome	10
18	fringed sagebrush	95
	hairy goldaster	0
	junegrass	0
	snowberry	25
	sun sedge	25
	white aster	10
	crazyweed	40
	wild rose	0
19	downy brome	0
	fringed sagebrush	95
	needleandthread	20
	sideoats grama	45
	snowberry	15
	sun sedge	30
	white aster	65

Appendix A4 continued. Vegetation frequency and percent green-up data.

Smiley Canyon Transect 2 – 10/17/07

Plot #	Plant Name	Green up
19	yucca	100
20	goldenrod	70
	hairy goldaster	5
	Kentucky bluegrass	35
	needleandthread	0
	smooth brome	30
	snowberry	20

Appendix A4 continued. Vegetation frequency and percent green-up data.

Saddle Rock Flats Transect 1 – 3/7/07

Plot #	Plant Name	Green up
1	blackroot	30
	smooth brome	40
	western ragweed	0
2	blackroot	40
	blue grama	0
	junegrass	40
	needleandthread	0
	pricklypear cactus	20
	western ragweed	0
	wheatgrass	70
3	downy brome	80
	junegrass	20
	Kentucky bluegrass	70
	white aster	0
	shelleaf penstemon	90
	unknown forb 3	100
	western ragweed	0
4	blackroot	30
	downy brome	70
	junegrass	15
	needleandthread	0
	pricklypear cactus	10
	western ragweed	0
	yucca	100
5	blackroot	40
	fringe sagebrush	40
	junegrass	10
	Kentucky bluegrass	80
	needleandthread	0
	wheatgrass	80
6	downy brome	85
	fringe sagebrush	30
	Kentucky bluegrass	80
	western ragweed	0
	yucca	100
7	blackroot	25
	downy brome	30
	goat's beard	0
	junegrass	0
	moss	100
	sideoats grama	0
	western ragweed	0
	wheatgrass	70
8	blackroot	20
	downy brome	70
	fringe sagebrush	50
	moss	100
	sand sagebrush	0
	wheatgrass	0
9	blackroot	10
	goat's beard	0
	hairy goldaster	100
	needleandthread	0
	prairie sandreed	0
	yucca	100
10	blackroot	60
	fringe sagebrush	15
	needleandthread	0
	slimflower scurfpea	0
11	blackroot	25
	downy brome	50
	fringe sagebrush	10
	Kentucky bluegrass	0
	needleandthread	0
	slimflower scurfpea	0
12	blackroot	10
	brittle cactus	100
	downy brome	30
	needleandthread	0
	slimflower scurfpea	0
	western ragweed	0
	yucca	100
13	blackroot	15
	fringe sagebrush	10
	Kentucky bluegrass	40
	little bluestem	0
	needleandthread	0
	sideoats grama	0
	yucca	100
14	blackroot	40
	downy brome	60
	yucca	0
15	blackroot	0
	downy brome	15
	Oenothera spp.	100
	prairie sandreed	0
	western ragweed	0
16	blackroot	10
	downy brome	10
	fringe sagebrush	30
	goat's beard	0
	junegrass	5
	wheatgrass	35
17	blue grama	0
	downy brome	45
	junegrass	0
	Kentucky bluegrass	15
	sideoats grama	0
	wheatgrass	25

Appendix A4 continued. Vegetation frequency and percent green-up data.

Saddle Rock Flats Transect 1 – 3/7/07

Plot #	Plant Name	Green up
17	yucca	100
18	blackroot	40
	blue grama	0
	downy brome	0
	fringe sagebrush	50
	needleandthread	0
	sand sagebrush	0
19	blackroot	30
	downy brome	65
	needleandthread	0
	phlox	90
	wheatgrass	80
20	downy brome	60
	goat's beard	0
	junegrass	0
	Kentucky bluegrass	70
	sand sagebrush	0
	western ragweed	0
21	downy brome	40
	prairie sandreed	0
	western ragweed	0
22	blackroot	30
	blue grama	0
	junegrass	0
23	blackroot	15
	junegrass	0
	wheatgrass	5
	yucca	100

Appendix A4 continued. Vegetation frequency and percent green-up data.

Saddle Rock Flats Transect 1 – 5/17/07

Plot #	Plant Name	Green up
1	blackroot	100
	blue grama	5
	junegrass	100
	prairie sandreed	100
	scarlet globemallow	100
	goat's beard	100
2	blackroot	100
	junegrass	100
	scarlet globemallow	100
	smooth Brome	100
	Japenes brome	100
	peppergrass	100
3	downy brome	100
	goat's beard	100
	junegrass	100
	needleandthread	100
	sixweeks fescue	100
	peppergrass	100
	silverleaf scurfpea	100
	Japenes brome	100
4	blackroot	100
	dandelion	100
	downy brome	100
	junegrass	100
	Kentucky bluegrass	100
	purple vetch	100
	scarlet globemallow	100
	peppergrass	100
	Japenes brome	100
	wheatgrass	100
5	downy brome	100
	purple vetch	100
	scarlet globemallow	100
6	horseweed	100
	Kentucky bluegrass	100
	purple vetch	100
	scarlet globemallow	100
	Japenes brome	100
7	blackroot	100
	Kentucky bluegrass	100
	purple vetch	100
	scarlet globemallow	100
	tumble mustard	100
	wheatgrass	100
8	blackroot	100
	rockcress	100
	junegrass	100
	Kentucky bluegrass	100
	prairie sandreed	100
	purple vetch	100
8	scarlet globemallow	100
	silverleaf scurfpea	100
	Japenes brome	100
	wheatgrass	100
9	blackroot	100
	downy brome	100
	fringe sagebrush	100
	Kentucky bluegrass	100
	needleandthread	100
	peppergrass	100
10	blackroot	100
	fringe sagebrush	100
	horseweed	100
	Kentucky bluegrass	100
	silver lupine	100
	silverleaf scurfpea	100
	Japenes brome	100
11	blackroot	100
	fringe sagebrush	100
	junegrass	100
	slimflower scurpea	100
	Japenes brome	100
	wheatgrass	100
12	blackroot	100
	dandelion	100
	fringe sagebrush	100
	junegrass	100
	puccoon	100
	Japenes brome	100
	wheatgrass	100
13	blackroot	100
	fringe sagebrush	100
	goat's beard	100
	purple vetch	100
	spiderwort	100
14	blackroot	100
	brittle cactus	100
	horseweed	100
	Kentucky bluegrass	100
	purple vetch	100
	sand sagebrush	100
	Japenes brome	100
	wheatgrass	100
15	blackroot	100
	blackroot	100
	fringe sagebrush	100
	junegrass	100
	purple vetch	100
	spiderwort	100
	Japenes brome	100
	yucca	100

Appendix A4 continued. Vegetation frequency and percent green-up data.

Saddle Rock Flats Transect 1 – 7/17/07

Plot #	Plant Name	Green up
1	blackroot	30
	goat's beard	0
	junegrass	5
	scarlet globemallow	20
	smooth brome	40
	yucca	60
2	blackroot	0
	junegrass	5
	needleandthread	10
	woolly plantain	0
3	blackroot	0
	junegrass	10
	needleandthread	15
	prairie sandreed	90
	pricklypear cactus	80
	whorled milkweed	40
	woolly plantain	0
4	downy brome	0
	western ragweed	85
	wheatgrass	55
5	downy brome	0
	fringed sagebrush	100
	western ragweed	90
	wheatgrass	30
6	blackroot	35
	downy brome	0
	junegrass	0
	Kentucky bluegrass	0
	needleandthread	10
	prairie sandreed	90
	sand sagebrush	100
	white aster	100
7	downy brome	0
	fringed sagebrush	100
	Japanese brome	0
	junegrass	5
	Kentucky bluegrass	0
	needleandthread	5
	prairie sandreed	95
	western ragweed	5
	woolly plantain	0
8	purple vetch	30
	Japanese brome	0
	Kentucky bluegrass	0
	needleandthread	0
	prairie sandreed	90
8	western ragweed	30
	white aster	60
	whorled milkweed	100
9	downy brome	0
	fringed sagebrush	100
	Japanese brome	0
	prairie sandreed	100
	silver lupine	70
10	blackroot	10
	fringed sagebrush	100
	Japanese brome	0
	Kentucky bluegrass	0
	prairie sandreed	95
	silver lupine	80
11	fringed sagebrush	100
	Japanese brome	0
	junegrass	5
	needleandthread	5
	white aster	100
	whorled milkweed	70
12	blackroot	5
	brittle cactus	85
	fringed sagebrush	100
	Japanese brome	0
	junegrass	0
	needleandthread	5
13	blackroot	5
	fringed sagebrush	100
	Japanese brome	0
	needleandthread	0
	white aster	90
14	blackroot	15
	Japanese brome	0
	needleandthread	10
	white aster	85
15	blackroot	25
	fringed sagebrush	100
	white aster	0
	yucca	100
16	blackroot	15
	fringed sagebrush	100
	Japanese brome	0
	junegrass	0
	needleandthread	0
	sand sagebrush	100
	white aster	80

Appendix A4 continued. Vegetation frequency and percent green-up data.

Saddle Rock Flats Transect 1 – 10/16/07

Plot #	Plant Name	Green up
1	blackroot	15
	blue grama	40
	junegrass	0
	smooth brome	0
	yucca	100
2	blackroot	5
	junegrass	0
	woolly plantain	0
3	blackroot	5
	downy brome	0
	western ragweed	95
4	downy brome	0
	western ragweed	90
	wheatgrass	25
5	downy brome	0
	prairie sandreed	30
	sand bluestem	0
	tumble mustard	0
	western ragweed	100
6	blackroot	5
	needleandthread	5
	pricklypear cactus	100
	western ragweed	0
	whorled milkweed	95
	yucca	100
7	blackroot	10
	prairie sandreed	5
	sand sagebrush	100
	western ragweed	70
	whorled milkweed	75
	woolly plantain	0
8	blackroot	5
	junegrass	0
	Kentucky bluegrass	0
8	needleandthread	0
	pricklypear cactus	100
	sand sagebrush	100
9	blackroot	0
	fringed sagebrush	95
	junegrass	0
	needleandthread	5
	skeleton weed	90
10	blackroot	10
	junegrass	0
	sand sagebrush	100
	skeleton weed	90
11	blackroot	40
	fringed sagebrush	75
	junegrass	0
	Kentucky bluegrass	0
	needleandthread	25
12	blackroot	15
	fringed sagebrush	100
	junegrass	0
	needleandthread	5
	sand dropseed	0
13	blackroot	15
	fringed sagebrush	100
	needleandthread	0
	sand sagebrush	100
	yucca	100
14	blackroot	5
	downy brome	0
	needleandthread	5
	wheatgrass	30
15	blackroot	0
	downy brome	0
	needleandthread	10

Appendix A4 continued. Vegetation frequency and percent green-up data.

Saddle Rock Flats Transect 2 – 5/17/07

Plot #	Plant Name	Green up
1	fringe sagebrush	100
	goat's beard	100
	junegrass	100
	sun sedge	100
	Japenese brome	100
	wheatgrass	100
	whorled milkweed	100
2	blackroot	100
	downy brome	100
	goat's beard	100
	junegrass	100
	needleandthread	100
	peppergrass	100
	Japenese brome	100
	whorled milkweed	100
3	blackroot	100
	goat's beard	50
	junegrass	100
	puccoon	100
	scarlet globemallow	100
	Japenese brome	100
4	blackroot	100
	blue grama	40
	goat's beard	100
	Kentucky bluegrass	100
	needleandthread	100
	puccoon	100
	spiderwort	100
	Japenese brome	100
	western wallflower	100
	wheatgrass	100
	whorled milkweed	100
5	downy brome	100
	fringe sagebrush	100
	Kentucky bluegrass	100
	needleandthread	100
	puccoon	100
	sand sagebrush	100
	scarlet globemallow	100
	silverleaf scurfpea	100
	Japenese brome	100
6	blackroot	100
	downy brome	100
	junegrass	40
	needleandthread	100
	sand sagebrush	100
	scarlet globemallow	100
	silverleaf scurfpea	100
	Japenese brome	100
	wheatgrass	100
7	blackroot	100
	desert stickseed	100
	Kentucky bluegrass	100
	needleandthread	100
	scarlet globemallow	100
	Japenese brome	100
	yucca	100
8	blackroot	100
	Kentucky bluegrass	100
	puccoon	100
	sand sagebrush	100
	Japenese brome	100
	wheatgrass	100
9	blackroot	100
	fringe sagebrush	100
	puccoon	100
	sand sagebrush	100
	scarlet globemallow	100
	western ragweed	100
	hawk's-beard	100
	wheatgrass	100
	whorled milkweed	100
	woolly plantain	100
10	fringe sagebrush	100
	Kentucky bluegrass	100
	prairie sandreed	60
	scarlet globemallow	100
	hawk's-beard	100
	Japenese brome	100
11	downy brome	100
	fringe sagebrush	100
	Kentucky bluegrass	100
	needleandthread	100
	prairie sandreed	100
	puccoon	100
	sand sagebrush	100
	scarlet globemallow	100
12	blackroot	100
	fringe sagebrush	100
	groundplum	100
	junegrass	100
	Kentucky bluegrass	100
	pricklypear cactus	100
	puccoon	100
	Japenese brome	100
	woolly plantain	100
13	blackroot	100
	fringe sagebrush	100
	horseweed	100
	prairie sandreed	100
14	blackroot	100

Appendix A4 continued. Vegetation frequency and percent green-up data.

Saddle Rock Flats Transect 2 – 5/17/07

Plot #	Plant Name	Green up
14	downy brome	100
	fringe sagebrush	100
	Kentucky bluegrass	100
	needleandthread	100
	puccoon	100
	scarlet globemallow	100
	sun sedge	100
	peppergrass	100
15	blackroot	100
	downy brome	100
	fringe sagebrush	100
	needleandthread	100
	prairie sandreed	100
	Japenese brome	100
	western wallflower	100
16	blackroot	100
	fringe sagebrush	100
	Japenese brome	100
	western wallflower	100
	wheatgrass	100
	yucca	100
17	blackroot	100
	fringe sagebrush	100
	needleandthread	100
	puccoon	100
	Japenese brome	100
	woolly plantain	100
18	blackroot	100
	death cambas	100
	fringe sagebrush	100
	needleandthread	100
	spiderwort	100
	Japenese brome	100
	wheatgrass	100
	yucca	100
19	blackroot	100
	purple vetch	100
	Japenese brome	100
	yucca	100
20	blackroot	100
	junegrass	100
20	prairie sandreed	100
	peppergrass	100
	wheatgrass	100
	yucca	100
21	blackroot	100
	rockcress	100
	fringe sagebrush	100
	junegrass	100
	scarlet globemallow	100
	Japenese brome	100
	whorled milkweed	100
	yucca	100
22	blackroot	100
	sun sedge	100
	Japenese brome	100
	wheatgrass	100
23	blackroot	100
	blue grama	20
	downy brome	100
	horseweed	100
	needleandthread	100
	puccoon	100
	sand sagebrush	100
	scarlet globemallow	100
	Japenese brome	100
	wheatgrass	100
24	blackroot	100
	downy brome	100
	fringe sagebrush	100
	needleandthread	100
	scarlet globemallow	100
	wheatgrass	100
25	blackroot	100
	fringe sagebrush	100
	horseweed	100
	Kentucky bluegrass	100
	puccoon	100
	sun sedge	100
	hawk's-beard	100
	Japenese brome	100
	wheatgrass	100

Appendix A4 continued. Vegetation frequency and percent green-up data.

Saddle Rock Flats Transect 2 – 7/17/07

Plot #	Plant Name	Green up
1	downy brome	0
	fringe sagebrush	100
	gayfeather	100
	junegrass	0
	needleandthread	20
	sand sagebrush	100
	whorled milkweed	100
2	blackroot	15
	blue grama	40
	downy brome	0
	Japanese brome	0
	junegrass	0
	needleandthread	15
	prairie sandreed	95
	whorled milkweed	100
	woolly plantain	0
3	blackroot	0
	gayfeather	100
	Japanese brome	0
	junegrass	0
	needleandthread	5
	whorled milkweed	100
	woolly plantain	0
4	blackroot	20
	Japanese brome	0
	junegrass	5
	needleandthread	10
	scarlet globemallow	60
	white aster	100
	woolly plantain	0
5	blackroot	15
	Kentucky bluegrass	0
	needleandthread	5
	scarlet globemallow	70
	white aster	95
	whorled milkweed	100
	woolly plantain	0
6	blackroot	15
	fringe sagebrush	100
	Japanese brome	0
	Kentucky bluegrass	0
	needleandthread	5
	pricklypear cactus	100
	whorled milkweed	100
	yucca	100
7	fringe sagebrush	100
	junegrass	5
	Kentucky bluegrass	0
	needleandthread	15
	scarlet globemallow	65
7	white aster	10
	whorled milkweed	100
8	blackroot	35
	fringe sagebrush	100
	Japanese brome	0
	Kentucky bluegrass	0
	needleandthread	20
	pricklypear cactus	85
	scarlet globemallow	40
	white aster	15
	whorled milkweed	100
9	blackroot	40
	blue grama	30
	fringe sagebrush	100
	Japanese brome	0
	Kentucky bluegrass	0
	needleandthread	10
	prairie sandreed	45
	sand sagebrush	100
10	blackroot	5
	blue grama	15
	brittle cactus	60
	Japanese brome	0
	junegrass	0
	needleandthread	5
	scarlet globemallow	30
	white aster	100
	woolly plantain	0
11	blackroot	5
	blue grama	15
	downy brome	0
	fringe sagebrush	100
	Japanese brome	0
	needleandthread	5
	whorled milkweed	100
12	blackroot	10
	fringe sagebrush	100
	Japanese brome	0
	needleandthread	0
	sand sagebrush	100
	whorled milkweed	100
13	blackroot	20
	blue grama	60
	goldenrod	100
	Japanese brome	0
	Kentucky bluegrass	0
	needleandthread	0
	prairie sandreed	100
	white aster	100
14	blackroot	0
	blue grama	20

Appendix A4 continued. Vegetation frequency and percent green-up data.

Saddle Rock Flats Transect 2 – 7/17/07

Plot #	Plant Name	Green up
14	Japanese brome	0
	Kentucky bluegrass	0
	needleandthread	5
	prairie sandreed	100
	western ragweed	25
	white aster	100
	yucca	100
15	blackroot	10
	Japanese brome	0
	junegrass	0
	needleandthread	15
	sand sagebrush	100
	yucca	0
16	blue grama	60
	downy brome	0
	Japanese brome	0
	junegrass	10
	Kentucky bluegrass	0
	needleandthread	5
	pricklypear cactus	100
	whorled milkweed	25
17	blackroot	10
	fringe sagebrush	100
	junegrass	5
	Kentucky bluegrass	0
	prairie sandreed	95
	white aster	95
18	blackroot	25
	Japanese brome	0
	Kentucky bluegrass	0
	prairie sandreed	100
	white aster	50
	woolly plantain	0
19	downy brome	0
	prairie sandreed	85
	scarlet globemallow	70
	yucca	100
20	blackroot	35
	downy brome	0
	fringe sagebrush	100
	needleandthread	20
	scarlet globemallow	55
	yucca	40
21	blackroot	70
	fringe sagebrush	100
	Japanese brome	0
	Kentucky bluegrass	0
	prairie sandreed	90
	rockcress	0
	whorled milkweed	100
	yucca	85
22	blackroot	10
	downy brome	0
	fringe sagebrush	100
	Japanese brome	0
	needleandthread	20
	pricklypear cactus	80
	sand sagebrush	40
23	blackroot	5
	fringe sagebrush	100
	Japanese brome	0
	junegrass	5
	needleandthread	10
	pricklypear cactus	100
24	blackroot	5
	blackroot	5
	Japanese brome	0
	needleandthread	15
	white aster	100
25	blackroot	15
	junegrass	0
	needleandthread	5
	prairie sandreed	100
	rockcress	0

Appendix A4 continued. Vegetation frequency and percent green-up data.

Saddle Rock Flats Transect 2 – 10/16/07

Plot #	Plant Name	Green up
1	blue grama	35
	downy brome	0
	fringe sagebrush	95
	junegrass	5
	sand sagebrush	80
	wheatgrass	50
2	blue grama	15
	downy brome	0
	junegrass	25
	needleandthread	5
	sand sagebrush	75
3	downy brome	0
	fringe sagebrush	95
	junegrass	5
	needleandthread	5
	yucca	100
4	blackroot	0
	downy brome	0
	junegrass	5
	needleandthread	0
	sand sagebrush	90
	whorled milkweed	45
	woolly plantain	0
5	blackroot	0
	fringe sagebrush	100
	junegrass	10
	Kentucky bluegrass	0
	needleandthread	0
	pricklypear cactus	90
	sun sedge	40
6	Kentucky bluegrass	0
	needleandthread	0
	sand sagebrush	100
	sun sedge	60
	whorled milkweed	25
7	downy brome	0
	junegrass	0
	needleandthread	0
	sand dropseed	0
	scarlet globemallow	80
	wheatgrass	10
8	blackroot	25
	downy brome	0
	junegrass	0
	sand sagebrush	95
	yucca	100
9	blackroot	0
	downy brome	0
	junegrass	0
9	needleandthread	15
	pricklypear cactus	10
10	blackroot	20
	downy brome	0
	fringe sagebrush	80
	junegrass	5
	needleandthread	5
	whorled milkweed	20
11	blackroot	5
	downy brome	0
	fringe sagebrush	85
	rockcress	100
	wheatgrass	30
12	fringe sagebrush	95
	junegrass	0
	needleandthread	5
	sand dropseed	0
	whorled milkweed	10
	yucca	100
13	blue grama	40
	junegrass	0
	needleandthread	5
	sand bluestem	0
	sun sedge	30
	whorled milkweed	20
	yucca	100
14	blackroot	30
	downy brome	0
	fringe sagebrush	95
	junegrass	0
	needleandthread	0
	sand bluestem	10
	woolly plantain	0
15	blackroot	35
	fringe sagebrush	85
	junegrass	0
	needleandthread	0
16	blackroot	15
	fringe sagebrush	75
	junegrass	0
	yucca	100
17	blackroot	40
	downy brome	0
	prairie sandreed	5
	sand sagebrush	95
	western ragweed	0
	yucca	100
18	blackroot	15
	fringe sagebrush	95
	needleandthread	25

Appendix A4 continued. Vegetation frequency and percent green-up data.

Saddle Rock Flats Transect 2 – 10/16/07

Plot #	Plant Name	Green up
18	puccoon	5
19	downy brome	0
	junegrass	0
	needleandthread	15
	wheatgrass	30
	whorled milkweed	45
20	blackroot	20
	yucca	100
21	blackroot	0
	fringe sagebrush	95
	needleandthread	20
	whorled milkweed	0
22	blackroot	0
	downy brome	0
	junegrass	0
	prairie sandreed	10
	sand dropseed	0
	yucca	100
23	blackroot	10
	yucca	100
24	blackroot	20
	blue grama	40
	downy brome	0
	fringe sagebrush	100
	sand bluestem	0
	yucca	100
25	blackroot	20
	needleandthread	0
	prairie sandreed	5
	sand sagebrush	100

Appendix A4 continued. Vegetation frequency and percent green-up data.

Saddle Rock Flats Transect 3 – 5/17/07

Plot #	Plant Name	Green up
1	fringe sagebrush	100
	smooth brome	100
	spiderwort	100
	tumble mustard	100
	lamb's quarters	100
2	desert stickseed	100
	sideoats grama	100
	peppergrass	100
	wheatgrass	100
3	blue grama	80
	desert stickseed	100
	horseweed	100
	sideoats grama	100
	spiderwort	100
	wheatgrass	100
4	blue grama	95
	desert stickseed	100
	downy brome	100
	fringe sagebrush	100
	horseweed	100
	sideoats grama	100
	spiderwort	100
	peppergrass	100
	tumble mustard	100
	wheatgrass	100
5	blackroot	100
	broom snakeweed	0
	desert stickseed	100
	fringe sagebrush	100
	scarlet gaura	100
	sideoats grama	100
	smooth brome	100
	tumble mustard	100
	yucca	100
6	fringe sagebrush	100
	needleandthread	100
	wheatgrass	100
7	blue grama	25
	desert stickseed	100
	scarlet gaura	100
	sideoats grama	100
	smooth brome	100
	yucca	100
8	desert stickseed	100
	fringe sagebrush	100
8	sideoats grama	100
	smooth brome	100
	tumble mustard	100
	wheatgrass	100
9	blue grama	85
	desert stickseed	100
	little bluestem	0
	sideoats grama	100
	wheatgrass	100
10	desert stickseed	100
	needleandthread	100
	sideoats grama	100
	smooth brome	100
	wheatgrass	100
11	desert stickseed	100
	needleandthread	100
	scarlet gaura	100
	sideoats grama	100
	smooth brome	100
	spiderwort	100
	wheatgrass	100
12	broom snakeweed	0
	fringe sagebrush	100
	sideoats grama	100
	peppergrass	100
	Japenese brome	100
	wheatgrass	100
13	fringe sagebrush	100
	needleandthread	100
	sideoats grama	100
	smooth brome	100
	wheatgrass	100
14	desert stickseed	100
	downy brome	100
	little bluestem	0
	needleandthread	100
	sideoats grama	100
	smooth brome	100
	peppergrass	100
15	desert stickseed	100
	needleandthread	100
	russian thistle	100
	sideoats grama	100
	smooth brome	100
	wheatgrass	100

Appendix A4 continued. Vegetation frequency and percent green-up data.

Saddle Rock Flats Transect 3 – 7/17/07

Plot #	Plant Name	Green up
1	fringe sagebrush	80
	western ragweed	100
2	blackroot	10
	needleandthread	20
	sideoats grama	50
3	desert stickseed	0
	downy brome	0
	sideoats grama	70
4	bush morningglory	100
	fringe sagebrush	100
	needleandthread	0
	peppergrass	0
	sideoats grama	60
	tumble mustard	0
	yucca	80
5	blackroot	70
	desert stickseed	0
	downy brome	0
	fringe sagebrush	100
	sideoats grama	30
6	fringe sagebrush	100
	needleandthread	15
	prairie sandreed	90
	russian thistle	100
	western ragweed	100
7	desert stickseed	0
	downy brome	0
	prairie sandreed	40
	russian thistle	100
	western ragweed	100
	yucca	100
8	desert stickseed	0
	needleandthread	0
	russian thistle	100
	western ragweed	100
8	wheatgrass	30
	yucca	100
9	blackroot	5
	desert stickseed	0
	downy brome	0
	russian thistle	90
	scarlet gaura	100
	yucca	100
10	fringe sagebrush	100
	sand dropseed	80
	scarlet gaura	100
	sideoats grama	20
11	blue grama	70
	downy brome	0
	prairie sandreed	90
	russian thistle	100
	sweetclover	100
	wheatgrass	30
12	fringe sagebrush	100
	russian thistle	100
	wheatgrass	60
13	desert stickseed	0
	downy brome	0
	needleandthread	15
	sweetclover	40
14	blue grama	15
	downy brome	0
	needleandthread	10
	wheatgrass	30
	yucca	100
15	downy brome	0
	russian thistle	100
	scarlet gaura	80
	sideoats grama	45
	wheatgrass	30

Appendix A4 continued. Vegetation frequency and percent green-up data.

Saddle Rock Flats Transect 3 – 10/16/07

Plot #	Plant Name	Green up
1	downy brome	0
	tumble mustard	0
	western ragweed	0
	yucca	100
2	blue grama	5
	desert stickseed	0
	needleandthread	5
	sand bluestem	0
3	scarlet guara	100
	sideoats grama	0
	wheatgrass	80
4	blue grama	20
	bush morninglory	0
	desert stickseed	0
	downy brome	0
	sideoats grama	0
5	dotted gayfeather	0
	fringe sagebrush	100
	sideoats grama	40
	snowberry	60
6	fringe sagebrush	100
	sideoats grama	35
	snowberry	75
7	blackroot	0
	needleandthread	0
8	downy brome	0
	sideoats grama	10
9	desert stickseed	0
	sand bluestem	0
	sideoats grama	30
	wheatgrass	0
	yucca	100
10	downy brome	0
	prairie sandreed	15
	sand dropseed	50
11	downy brome	0
	fringe sagebrush	0
	sideoats grama	5
12	fringe sagebrush	80
	needleandthread	25
	scarlet guara	100
13	desert stickseed	0
	downy brome	0
	needleandthread	5
	wheatgrass	5
14	broom snakeweed	100
	downy brome	0
	needleandthread	30
	wheatgrass	10
	yucca	25
15	needleandthread	25
	sand dropseed	0
	scarlet guara	100
	sideoats grama	40

Appendix A4 continued. Vegetation frequency and percent green-up data.

Saddle Rock Flats Transect 4 – 3/7/07

Plot #	Plant Name	Green up
1	black root	25
	brittle cactus	30
	junegrass	10
	sand sagebrush	0
	wheatgrass	40
2	black root	20
	junegrass	10
	prairie sandreed	0
	yucca	80
3	brittle cactus	10
	downy brome	0
	junegrass	0
	moss	100
	needleandthread	0
4	black root	30
	blue grama	0
	junegrass	0
	sand sagebrush	0
5	black root	35
	blue grama	0
	downy brome	70
	junegrass	25
	needleandthread	0
6	black root	10
	downy brome	0
	junegrass	15
	prairie sandreed	0
	sand bluestem	0
	wheatgrass	35
7	black root	15
	downy brome	10
	goat's beard	0
	needleandthread	0
	sand sagebrush	0
	western ragweed	0
8	downy brome	20
	sand bluestem	0
	sand sagebrush	0
	western ragweed	0
	wheatgrass	30
9	Oenothera spp.	100
	prairie sandreed	0
	western ragweed	0
	yucca	100
10	blue grama	0
	downy brome	60
	horseweed	0
	Kentucky bluegrass	70
	yucca	100
11	downy brome	70
	Kentucky bluegrass	65
	prairie sandreed	0
	wheatgrass	30
12	black root	5
	downy brome	30
	goat's beard	100
	needleandthread	0
13	black root	15
	downy brome	5
	Kentucky bluegrass	0
14	black root	10
	blue grama	0
	downy brome	10
	Kentucky bluegrass	0
	needleandthread	0
15	black root	5
	needleandthread	0
16	black root	5
	needleandthread	0
	yucca	100
17	black root	5
	downy brome	30
	needleandthread	0
	sand sagebrush	0
18	black root	10
	needleandthread	0
	yucca	100
19	downy brome	40
	needleandthread	0
20	black root	5
	downy brome	5
	needleandthread	0
21	black root	25
	downy brome	50
	needleandthread	0
22	black root	15
	blue grama	0
	downy brome	30
23	downy brome	15
	Kentucky bluegrass	50
	wheatgrass	30
24	blue grama	0
	downy brome	15
	Kentucky bluegrass	50
25	downy brome	40
	needleandthread	0
26	downy brome	5
	hoary verbain	10
	Kentucky bluegrass	0

Appendix A4 continued. Vegetation frequency and percent green-up data.

Saddle Rock Flats Transect 4 – 3/7/07

Plot #	Plant Name	Green up
26	yucca	100
27	black root	10
	dandelion	80
	Kentucky bluegrass	40
28	downy brome	60
	Kentucky bluegrass	30
29	downy brome	40
	Kentucky bluegrass	80
30	Kentucky bluegrass	20
	shelleaf penstemon	0
	yucca	100

Appendix A4 continued. Vegetation frequency and percent green-up data.

Saddle Rock Flats Transect 4 – 5/17/07

Plot #	Plant Name	Green up
1	blackroot	100
	brittle Cactus	100
	junegrass	100
	needleandthread	100
	puccoon	100
	sand sagebrush	100
	sixweek fescue	100
	skeleton rush	100
	peppergrass	100
	wheatgrass	100
2	blackroot	100
	junegrass	100
	Kentucky bluegrass	100
	prairie sandreed	100
	goat's beard	100
	Japenese brome	100
	woolly plantain	100
	yucca	100
3	blackroot	100
	blue grama	50
	brittle Cactus	100
	goat's beard	100
	junegrass	100
	puccoon	100
	sand sagebrush	100
	sixweek fescue	100
	peppergrass	100
	woolly plantain	100
4	blackroot	100
	downy brome	100
	horseweed	100
	junegrass	100
	needleandthread	100
	sand sagebrush	100
	woolly plantain	100
5	blackroot	100
	downy brome	100
	junegrass	100
	needleandthread	100
	scarlet globemallow	100
	peppergrass	100
	Japenese brome	100
	whorled milkweed	100
6	blackroot	100
	junegrass	100
	prairie sandreed	70
	whorled milkweed	100
7	junegrass	100
	pricklypear cactus	100
	sand bluestem	0
7	smooth brome	100
	Japenese brome	100
	whorled milkweed	100
8	bush morningglory	0
	downy brome	100
	goat's beard	0
	sand sagebrush	100
	scarlet globemallow	100
	wheatgrass	100
9	blackroot	100
	downy brome	100
	needleandthread	100
	scarlet globemallow	100
	goat's beard	100
	Japenese brome	100
	wheatgrass	100
10	blackroot	100
	downy brome	100
	horseweed	100
	needleandthread	100
	Japenese brome	100
	wheatgrass	100
11	downy brome	100
	horseweed	100
	Kentucky bluegrass	100
	prairie sandreed	100
	Japenese brome	100
	wheatgrass	100
12	downy brome	100
	Kentucky bluegrass	100
	needleandthread	100
	Japenese brome	100
	wheatgrass	100
13	blackroot	100
	desert stickseed	100
	downy brome	100
	needleandthread	100
	wheatgrass	100
14	blackroot	100
	downy brome	100
	needleandthread	100
	Japenese brome	100
15	blackroot	100
	sixweek fescue	100
	peppergrass	100
	flax spp.	100
	Japenese brome	100
16	blackroot	100
	downy brome	100
	needleandthread	100

Appendix A4 continued. Vegetation frequency and percent green-up data.

Saddle Rock Flats Transect 4 – 5/17/07

Plot #	Plant Name	Green up
16	goat's beard	100
	Japenese brome	100
17	blackroot	100
	sixweek fescue	100
	woolly plantain	100
18	blackroot	100
	needleandthread	100
	Japenese brome	100
	whorled milkweed	100
19	blackroot	100
	horseweed	100
	Japenese brome	100
20	blackroot	100
	goat's beard	100
	needleandthread	100
	yucca	100
21	downy brome	100
	Japenese brome	100
	wavyleaf thistle	100
	wheatgrass	100
	yucca	100
22	blackroot	100
	downy brome	100
	needleandthread	100
	Japenese brome	100
	yucca	100
23	blackroot	100
	Kentucky bluegrass	100
	needleandthread	100
	Japenese brome	100
24	downy brome	100
	Kentucky bluegrass	100
24	Japenese brome	100
25	blue grama	100
	cudweed sagewort	100
	downy brome	100
	Kentucky bluegrass	100
	Japenese brome	100
26	downy brome	100
	Kentucky bluegrass	100
	needleandthread	100
	Japenese brome	100
27	downy brome	100
	Kentucky bluegrass	100
	mullien	100
	puccoon	100
	goat's beard	100
	Japenese brome	100
28	downy brome	100
	Kentucky bluegrass	100
	needleandthread	100
	Japenese brome	100
	wheatgrass	100
29	blackroot	100
	Kentucky bluegrass	100
	needleandthread	100
	puccoon	100
	Japenese brome	100
30	bush morningglory	0
	dandelion	100
	Kentucky bluegrass	100
	goat's beard	100
	wavyleaf thistle	100
	wheatgrass	100

Appendix A4 continued. Vegetation frequency and percent green-up data.

Saddle Rock Flats Transect 4 – 7/17/07

Plot #	Plant Name	Green up
1	blackroot	0
	brittle cactus	90
	junegrass	0
	needleandthread	0
	peppergrass	0
	sand sagebrush	100
	skeletonweed	70
2	blackroot	0
	downy brome	0
	goat's beard	0
	junegrass	0
	needleandthread	0
	prairie sandreed	80
	yucca	30
3	blackroot	0
	junegrass	0
	needleandthread	0
	sand sagebrush	100
	woolly plantain	0
4	blackroot	0
	downy brome	0
	junegrass	0
	needleandthread	0
	peppergrass	0
	prairie sandreed	60
	scarlet gaura	100
	sideoats grama	15
	whorled milkweed	80
	woolly plantain	0
5	downy brome	0
	junegrass	5
	needleandthread	15
	sand bluestem	0
	western ragweed	100
6	blackroot	0
	junegrass	0
	needleandthread	0
	prairie sandreed	90
	sand dropseed	0
7	blackroot	40
	downy brome	0
	junegrass	0
	needleandthread	0
	prairie sandreed	95
	sand dropseed	0
8	blackroot	0
	junegrass	0
	needleandthread	0
9	downy brome	0
	prairie sandreed	70
	western ragweed	90
10	blackroot	60
	downy brome	0
	needleandthread	0
	prairie sandreed	90
	sand dropseed	0
	western ragweed	0
	yucca	0
11	blackroot	20
	blue grama	30
	bush morningglory	100
	downy brome	0
	Kentucky bluegrass	0
	needleandthread	0
	western ragweed	100
12	downy brome	0
	Kentucky bluegrass	0
	prairie sandreed	95
	whorled milkweed	100
13	blackroot	0
	blue grama	0
	downy brome	0
	scarlet globemallow	5
	skeletonweed	100
14	blackroot	0
	Japanese brome	0
	needleandthread	0
	scarlet globemallow	5
	skeletonweed	100
15	blackroot	0
	needleandthread	0
	skeletonweed	100
16	blackroot	0
	downy brome	0
	needleandthread	0
	skeletonweed	100
17	blackroot	0
	Japanese brome	0
	needleandthread	0
	pricklypear cactus	100
18	blackroot	25
	downy brome	0
	Japanese brome	0
	needleandthread	0
	wheatgrass	30
19	goat's beard	0
	Japanese brome	0
	needleandthread	0
	prairie sandreed	95

Appendix A4 continued. Vegetation frequency and percent green-up data.

Saddle Rock Flats Transect 4 – 7/17/07

Plot #	Plant Name	Green up
19	whorled milkweed	0
20	blackroot	0
	Japanese brome	0
	needleandthread	0
	scarlet gaura	100
	wheatgrass	20
21	downy brome	0
	prairie sandreed	40
	wheatgrass	10
	yucca	100
22	blackroot	0
	Japanese brome	0
	Kentucky bluegrass	0
	needleandthread	0
23	blackroot	40
	Japanese brome	0
	Kentucky bluegrass	0
	needleandthread	0
24	Japanese brome	0
	Kentucky bluegrass	0
	needleandthread	0
	prairie sandreed	45
	scarlet globemallow	15
25	Japanese brome	0
	needleandthread	0
26	downy brome	0
	Kentucky bluegrass	0
	western ragweed	100
	wheatgrass	65
27	Japanese brome	0
	Kentucky bluegrass	0
	needleandthread	0
	wheatgrass	60
28	blackroot	5
	Japanese brome	0
	Kentucky bluegrass	0
	needleandthread	0
	yucca	75
29	bush morningglory	100
	downy brome	0
	Kentucky bluegrass	0
	wheatgrass	45
30	Japanese brome	0
	Kentucky bluegrass	0
	wheatgrass	50
	yucca	100

Appendix A4 continued. Vegetation frequency and percent green-up data.

Saddle Rock Flats Transect 4 – 10/16/07

Plot #	Plant Name	Green up
1	blackroot	5
	brittle cactus	85
	junegrass	0
	sand sagebrush	95
	skeleton weed	0
2	blackroot	10
	Kentucky bluegrass	0
	needleandthread	0
	prairie sandreed	30
	sand bluestem	0
	yucca	100
3	blackroot	10
	brittle cactus	20
	downy brome	0
	needleandthread	5
	whorled milkweed	80
	woolly plantain	0
	yucca	0
4	blackroot	15
	downy brome	0
	needleandthread	5
	prairie sandreed	20
	sand sagebrush	100
	shelleaf penstemon	0
	western ragweed	0
	woolly plantain	0
5	blackroot	0
	downy brome	0
	junegrass	0
	needleandthread	15
	sand bluestem	0
6	blackroot	5
	junegrass	0
	sand bluestem	0
	sideoats grama	0
7	blackroot	0
	needleandthread	0
	sand bluestem	0
8	blackroot	15
	downy brome	0
	needleandthread	0
9	junegrass	0
	sand bluestem	0
	western ragweed	0
	wheatgrass	20
10	blue grama	25
	downy brome	0
	Kentucky bluegrass	0
	needleandthread	0
10	prairie sandreed	20
	whorled milkweed	30
11	downy brome	0
	needleandthread	5
	prairie sandreed	15
	wheatgrass	20
12	blackroot	0
	blue grama	30
	downy brome	0
	needleandthread	5
	skeleton weed	80
13	blackroot	5
	blue grama	40
	downy brome	0
	needleandthread	45
	wheatgrass	60
14	blackroot	0
	downy brome	0
	needleandthread	15
	pricklypear cactus	100
	yucca	100
15	blackroot	0
	blue grama	15
	downy brome	0
	needleandthread	10
16	blackroot	0
	prairie sandreed	0
	yucca	100
17	blackroot	0
	blue grama	10
	needleandthread	0
	skeleton weed	80
	yucca	100
18	blackroot	10
	bush morningglory	0
	downy brome	0
	needleandthread	15
	wheatgrass	25
19	blackroot	15
	needleandthread	10
	pricklypear cactus	90
	whorled milkweed	75
	yucca	100
20	blue grama	35
	downy brome	0
	Kentucky bluegrass	0
	needleandthread	5
	yucca	100
21	blue grama	15
	downy brome	0

Appendix A4 continued. Vegetation frequency and percent green-up data.

Saddle Rock Flats Transect 4 – 10/16/07

Plot #	Plant Name	Green up
21	Kentucky bluegrass	0
	needleandthread	0
22	blackroot	0
	downy brome	0
	wheatgrass	10
23	blue grama	45
	downy brome	0
	Kentucky bluegrass	0
	needleandthread	15
24	blue grama	30
	downy brome	0
	Kentucky bluegrass	0
	needleandthread	35
25	blue grama	30
	downy brome	0
	Kentucky bluegrass	0
	needleandthread	40
	western ragweed	90
	wheatgrass	30
26	downy brome	0
	Kentucky bluegrass	0
	wheatgrass	60
27	downy brome	0
	Kentucky bluegrass	0
	needleandthread	10
	wheatgrass	45
	yucca	15
28	blue grama	10
	downy brome	0
	Kentucky bluegrass	0
	needleandthread	25
	wheatgrass	30
29	downy brome	0
	Kentucky bluegrass	0
	needleandthread	20
	yucca	100
30	scarlet globemallow	100
	wheatgrass	80
	yucca	100

Appendix A4 continued. Vegetation frequency and percent green-up data.

Smiley Canyon Windmill Transect 1 – 3/7/07

Plot #	Plant Name	Green up
1	crested wheatgrass	0
	downy brome	40
2	downy brome	80
	western ragweed	0
	wheat grass	90
3	downy brome	5
	sweet clover	0
	western ragweed	0
4	sun sedge	40
	western ragweed	0
	wheat grass	0
5	sweet clover	0
	western ragweed	0
	wheat grass	0
6	needleandthread	0
	western ragweed	0
	wheat grass	5
7	annual sunflower	0
	downy brome	40
	western ragweed	0
	wheat grass	0
8	cudweed sgaewort	0
	downy brome	25
	sweet clover	0
9	downy brome	30
	sweet clover	0
10	downy brome	15
	sweet clover	0
	wheat grass	20
11	downy brome	5
	Kentucky bluegrass	0
12	wheat grass	5
13	downy brome	40
	sweet clover	0
13	wheat grass	30
14	downy brome	5
	wheat grass	5
15	downy brome	20
	sweet clover	0
	wheat grass	30
16	downy brome	10
	wheat grass	5
17	downy brome	40
	sweet clover	0
	wheat grass	60
18	downy brome	5
	sun sedge	80
19	downy brome	40
	sun sedge	30
	sweet clover	0
	wheat grass	5
20	downy brome	5
	little bluestem	0
	sun sedge	10
	sweet clover	0
	wheat grass	5
21	downy brome	40
	wheat grass	5
22	downy brome	10
	needleandthread	0
	wheat grass	0
23	downy brome	50
	sweet clover	0
	western ragweed	0
24	annual sunflower	0
	downy brome	5
	western ragweed	0
	wheat grass	5
25	downy brome	5

Appendix A4 continued. Vegetation frequency and percent green-up data.

Smiley Canyon Windmill Transect 1 – 5/19/07

Plot #	Plant Name	Green up
1	peppergrass	100
	downy brome	100
	Kentucky bluegrass	100
	scarlet globemallow	100
	Japenese brome	100
	wheatgrass	100
2	alfalfa	100
	downy brome	100
	scarlet globemallow	100
	shelleaf penstemon	100
	Japenese brome	100
	wheatgrass	100
3	downy brome	100
	puccon	100
	smooth brome	100
	sun sedge	100
	Japenese brome	100
	wheatgrass	100
4	downy brome	100
	scarlet globemallow	100
	Japenese brome	100
	wheatgrass	100
5	cudweed sagewort	100
	downy brome	100
	scarlet globemallow	100
6	downy brome	100
	scarlet globemallow	100
	wheatgrass	100
7	blackroot	100
	downy brome	100
	needleandthread	100
	scarlet globemallow	100
	Japenese brome	100
	annual mustard	100
8	peppergrass	100
	downy brome	100
	scarlet globemallow	100
	wheatgrass	100
9	peppergrass	100
	downy brome	100
	scarlet globemallow	100
	skeleton rush	100
	wheatgrass	100
10	downy brome	100
	scarlet globemallow	100
	wheatgrass	100
11	downy brome	100
	scarlet globemallow	100
	wheatgrass	100
12	downy brome	100
	fringe sagebrush	100
	goat's beard	100
	Japenese brome	100
	wheatgrass	100
13	downy brome	100
	skeleton rush	100
	Japenese brome	100
	wheatgrass	100
14	downy brome	100
	Japenese brome	100
	wheatgrass	100
15	downy brome	100
	scarlet globemallow	100
	Japenese brome	100
	wheatgrass	100
16	downy brome	100
	scarlet globemallow	100
	sun sedge	100
	wheatgrass	100
	annual mustard	100
17	alfalfa	100
	downy brome	100
	puccon	100
	scarlet globemallow	100
	Japenese brome	100
	wheatgrass	100
18	downy brome	100
	skeleton rush	100
	wheatgrass	100
19	downy brome	100
	puccon	100
	Japenese brome	100
	wheatgrass	100
20	needleandthread	100
	puccon	100
	scarlet globemallow	100
	smooth brome	100
	spiderwort	100
21	downy brome	100
	needleandthread	100
	puccon	100
	sun sedge	100
	Japenese brome	100
22	downy brome	100
	skeleton rush	100
	wheatgrass	100
23	alfalfa	100
	downy brome	100
	scarlet globemallow	100

Appendix A4 continued. Vegetation frequency and percent green-up data.

Smiley Canyon Windmill Transect 1 – 5/19/07

Plot #	Plant Name	Green up
23	scarlet globemallow	100
	sun sedge	100
	wheatgrass	100
24	downy brome	100
	needleandthread	100
	scarlet globemallow	100
	skeleton rush	100
	wheatgrass	100
25	downy brome	100
	scarlet globemallow	100
	wheatgrass	100

Appendix A4 continued. Vegetation frequency and percent green-up data.

Smiley Canyon Windmill Transect 1 – 7/19/07

Plot #	Plant Name	Green up
1	downy brome	0
	Japanese brome	0
	Virginia groundcherry	100
	wheatgrass	15
2	downy brome	0
	Japanese brome	0
	needleandthread	0
	scarlet gaura	100
	Virginia groundcherry	100
	wheatgrass	60
3	downy brome	0
	goat's beard	0
	Japanese brome	0
	needleandthread	35
	smooth brome	80
	wheatgrass	75
	white aster	100
4	downy brome	0
	Japanese brome	0
	needleandthread	10
	peppergrass	0
	western ragweed	10
	wheatgrass	70
5	cudweed sagewort	100
	downy brome	0
	Virginia groundcherry	100
	wheatgrass	40
6	downy brome	0
	Japanese brome	0
	peppergrass	0
	skeletonweed	100
	tumblemustard	0
	western ragweed	50
	wheatgrass	80
7	fringe sagebrush	100
	Japanese brome	0
	needleandthread	0
	western ragweed	5
	wheatgrass	65
8	downy brome	0
	Japanese brome	0
	needleandthread	10
	tumblemustard	0
	western ragweed	60
	wheatgrass	85
9	downy brome	0
	tumblemustard	0
	scarlet Guara	100
	western ragweed	100
	wheatgrass	75
10	downy brome	0
	peppergrass	0
	tumblemustard	0
	western ragweed	20
	wheatgrass	60
	white aster	100
11	downy brome	0
	Japanese brome	0
	skeletonweed	100
	sweetclover	90
12	downy brome	0
	skeletonweed	100
	sun sedge	0
	tumblemustard	0
	wheatgrass	60
13	downy brome	0
	scarlet gaura	100
	skeletonweed	100
	sun sedge	10
	Virginia groundcherry	100
	wheatgrass	90
14	downy brome	0
	Japanese brome	0
	needleandthread	25
	sun sedge	5
	wheatgrass	45
15	downy brome	0
	Japanese brome	0
	scarlet globemallow	100
	skeletonweed	40
	sun sedge	0
	Virginia groundcherry	100
	wheatgrass	25
16	downy brome	0
	Japanese brome	0
	needleandthread	5
	sand dropseed	95
	Virginia groundcherry	100
17	Japanese brome	0
	tumblemustard	0
	Virginia groundcherry	100

Appendix A4 continued. Vegetation frequency and percent green-up data.

Smiley Canyon Windmill Transect 1 – 7/19/07

Plot #	Plant Name	Green up
17	wheatgrass	60
18	Japanese brome	0
	needleandthread	10
	scarlet globemallow	100
	wheatgrass	60
19	Japanese brome	0
	needleandthread	0
	sand dropseed	95
	skeletonweed	100
	sun sedge	5
	Virginia groundcherry	100
20	downy brome	0
	Japanese brome	0
	skeletonweed	45
	sun sedge	5
	white aster	0

Appendix A4 continued. Vegetation frequency and percent green-up data.

Smiley Canyon Windmill Transect 1 – 10/17/07

Plot #	Plant Name	Green up
1	downy brome	0
	peppergrass	0
	prairie sandreed	15
	western ragweed	95
	wheatgrass	20
2	downy brome	0
	needleandthread	30
	russian thistle	100
	sand dropseed	25
	sweet clover	0
	western ragweed	0
	wheatgrass	15
3	downy brome	0
	goat's beard	0
	sand dropseed	10
	smooth brome	5
	Virginia groundcherry	100
	wheatgrass	10
	white aster	15
4	downy brome	0
	goat's beard	0
	needleandthread	10
	peppergrass	0
	sun sedge	30
	Virginia groundcherry	35
	western ragweed	0
	wheatgrass	15
5	cudweed sagewort	100
	downy brome	0
	skeleton weed	100
	sun sedge	20
	western ragweed	25
6	downy brome	0
	fringe sagebrush	85
	peppergrass	0
	skeleton weed	80
	tumble mustard	0
	wheatgrass	30
7	downy brome	0
	needleandthread	25
	sun sedge	20
	tumble mustard	0
8	downy brome	5
	needleandthread	10
	skeleton weed	80
9	downy brome	0
	Kentucky bluegrass	0
9	tumble mustard	0
	Virginia groundcherry	95
	wheatgrass	20
10	downy brome	0
	sand dropseed	95
	sun sedge	10
	wheatgrass	30
11	downy brome	0
	sun sedge	40
	western ragweed	0
	wheatgrass	35
12	downy brome	0
	sun sedge	10
	wheatgrass	20
13	downy brome	0
	russian thistle	100
	skeleton weed	0
	sun sedge	60
	tumble mustard	0
	Virginia groundcherry	100
14	little bluestem	0
	skeleton weed	0
	sun sedge	45
	wheatgrass	35
15	downy brome	0
	sun sedge	0
	Virginia groundcherry	100
16	downy brome	0
	needleandthread	35
	wheatgrass	25
17	downy brome	0
	needleandthread	45
	scarlet globemallow	35
	western ragweed	0
18	downy brome	0
	needleandthread	30
	sun sedge	35
	tumble mustard	0
19	downy brome	0
	needleandthread	25
	skeleton weed	40
	tumble mustard	0
20	downy brome	0
	needleandthread	10
	sun sedge	55
	wheatgrass	15

Appendix A4 continued. Vegetation frequency and percent green-up data.

Smiley Canyon Windmill Transect 2 – 3/7/07

Plot #	Plant Name	Green up
1	downy brome	30
	junegrass	5
	Kentucky bluegrass	10
	needleandthread	0
	sand dropseed	0
	shelleaf penstemon	0
	sun sedge	50
2	downy brome	0
	Kentucky bluegrass	5
	sun sedge	25
3	downy brome	0
	shelleaf penstemon	0
	western ragweed	0
	wheatgrass	5
4	Kentucky bluegrass	5
	little bluestem	0
	sun sedge	65
	western ragweed	0
5	downy brome	0
	fringe sagebrush	50
	sun sedge	10
6	Kentucky bluegrass	0
	sun sedge	10
	western ragweed	0
	wheatgrass	0
7	downy brome	0
	sand dropseed	0
	western ragweed	0
	wheatgrass	15
8	downy brome	45
	sweet clover	0
	western ragweed	0
9	downy brome	0
	sun sedge	10
	western ragweed	0
10	blue grama	0
	downy brome	5
	sun sedge	25
	sweet clover	0
	wheatgrass	15
11	annual sunflower	0
	downy brome	10
	Kentucky bluegrass	60
	sweet clover	0
	texas Croton	0
12	downy brome	5
	sun sedge	15
	sweet clover	0
	western ragweed	0
	wheatgrass	10
13	fringe sagebrush	60
	Kentucky bluegrass	10
	white aster	0
	prairie sandreed	0
	western ragweed	0
	yucca	40
14	downy brome	5
	goat's beard	0
	smooth brome	20
	wheatgrass	5
15	downy brome	5
	sand dropseed	0
	wheatgrass	5
16	downy brome	5
	Kentucky bluegrass	10
	sand dropseed	0
17	blue grama	0
	downy brome	0
	sand dropseed	0
	western ragweed	0
	wheatgrass	5
18	Kentucky bluegrass	0
	western ragweed	0
	wheatgrass	0
19	downy brome	0
	western ragweed	0
	wheatgrass	0
20	annual sunflower	0
	downy brome	15
	sand dropseed	0
	western ragweed	0

Appendix A4 continued. Vegetation frequency and percent green-up data.

Smiley Canyon Windmill Transect 2 – 5/19/07

Plot #	Plant Name	Green up
1	Kentucky bluegrass	100
	needleandthread	100
	puccoon	100
	shelleaf pestemon	100
	sun sedge	100
	Japenese brome	100
	wheatgrass	100
2	junegrass	100
	sun sedge	100
	Japenese brome	100
3	Kentucky bluegrass	100
	shelleaf pestemon	100
	sun sedge	100
	Japenese brome	100
	wheatgrass	100
4	downy brome	100
	puccoon	100
	sun sedge	100
	Japenese brome	100
	wheatgrass	100
5	downy brome	100
	needleandthread	100
	sun sedge	100
	Japenese brome	100
	wheatgrass	100
6	Kentucky bluegrass	100
	scarlet globemallow	100
	sun sedge	100
	Japenese brome	100
7	downy brome	100
	scarlet globemallow	100
	skeleton rush	100
	sun sedge	100
	Japenese brome	100
	western ragweed	0
8	downy brome	100
	Japenese brome	100
	wheatgrass	100
	annual mustard	100
9	Kentucky bluegrass	100
	scarlet globemallow	100
	Japenese brome	100
	western ragweed	0
10	Kentucky bluegrass	100
	needleandthread	100
	puccoon	100
	sun sedge	100
	Japenese brome	100
11	Kentucky bluegrass	100
	needleandthread	100
	shelleaf pestemon	100
	Japenese brome	100
12	downy brome	100
	needleandthread	100
	puccoon	100
	Japenese brome	100
13	fringe sagebrush	100
	Kentucky bluegrass	100
	puccoon	100
	scarlet globemallow	100
	sun sedge	100
	goat's beard	100
	wheatgrass	100
14	needleandthread	100
	scarlet globemallow	100
	sun sedge	100
	Japenese brome	100
15	needleandthread	100
	scarlet globemallow	100
	Japenese brome	100
	wheatgrass	100
16	downy brome	100
	needleandthread	100
	Scribners panicum	100
	sixweeks fescue	100
	sun sedge	100
	Japenese brome	100
17	needleandthread	100
	scarlet globemallow	100
	Scribners panicum	100
	sixweeks fescue	100
	sun sedge	100
18	Kentucky bluegrass	100
	needleandthread	100
	scarlet globemallow	100
	Japenese brome	100
	wheatgrass	100
19	downy brome	100
	puccoon	100
	scarlet globemallow	100
	sun sedge	100
	wheatgrass	100
20	downy brome	100
	fringe sagebrush	100
	needleandthread	100
	scarlet globemallow	100
	sun sedge	100
	Japenese brome	100

Appendix A4 continued. Vegetation frequency and percent green-up data.

Smiley Canyon Windmill Transect 2 – 7/19/07

Plot #	Plant Name	Green up
1	Japanese brome	0
	junegrass	0
	Kentucky bluegrass	0
	needleandthread	10
	sun sedge	20
	white aster	0
2	fringe sagebrush	100
	Japanese brome	0
	junegrass	10
	needleandthread	5
	Scribner's panicum	100
	sun sedge	10
3	Japanese brome	0
	Kentucky bluegrass	0
	needleandthread	10
	sun sedge	40
	western ragweed	0
	wheatgrass	20
4	Japanese brome	0
	Kentucky bluegrass	0
	needleandthread	0
	puccoon	100
	sun sedge	30
	whorled milkweed	100
5	Japanese brome	0
	sun sedge	5
	Virginiga groundcherry	100
	woolly plantain	0
6	Japanese brome	0
	Kentucky bluegrass	0
	needleandthread	5
	sun sedge	30
	wheatgrass	10
	white aster	0
7	Japanese brome	0
	Kentucky bluegrass	0
	little bluestem	10
	needleandthread	10
	sun sedge	5
	sweetclover	0
	wheatgrass	25
8	Japanese brome	0
	needleandthread	0
	sun sedge	5
	western ragweed	0
8	wheatgrass	60
9	blackroot	5
	Japanese brome	0
	Kentucky bluegrass	0
	needleandthread	25
	sun sedge	5
	western ragweed	0
10	downy brome	0
	Japanese brome	0
	needleandthread	15
	Scribner's panicum	100
	sun sedge	10
	western ragweed	0
11	Japanese brome	0
	needleandthread	10
	sun sedge	100
	Virginiga groundcherry	100
	wheatgrass	30
	wheatgrass	70
12	downy brome	0
	Scribner's panicum	100
	sun sedge	0
	wheatgrass	30
13	Japanese brome	0
	Kentucky bluegrass	0
	scarlet globemallow	100
	western ragweed	0
	wheatgrass	10
	white aster	100
	wucca	100
14	Japanese brome	0
	needleandthread	5
	sun sedge	5
	wheatgrass	5
	white aster	100
15	fringe sagebrush	100
	Japanese brome	0
	needleandthread	15
	Scribner's panicum	100
	western ragweed	65
16	fringe sagebrush	100
	Japanese brome	0
	needleandthread	0
	Scribner's panicum	100
	sixweeksfescue	0

Appendix A4 continued. Vegetation frequency and percent green-up data.

Smiley Canyon Windmill Transect 2 – 7/19/07

Plot #	Plant Name	Green up
16	sun sedge	10
17	Japanese brome	0
	needleandthread	10
	scarlet globemallow	100
	western ragweed	0
18	Japanese brome	0
	Kentucky bluegrass	0
	Kentucky bluegrass	5
	Scribner's panicum	100
	wheatgrass	65
19	downy brome	0
	Japanese brome	0
	Scribner's panicum	100
	Virginiga groundcherry	100
	western ragweed	0
20	downy brome	0
	needleandthread	0
	prairie sandreed	100
	tumblemustard	0
	Virginiga groundcherry	100
	western ragweed	0

Appendix A4 continued. Vegetation frequency and percent green-up data.

Smiley Canyon Windmill Transect 2 – 10/17/07

Plot #	Plant Name	Green up
1	downy brome	0
	junegrass	0
	Kentucky bluegrass	0
	needleandthread	25
	puccoon	0
	sun sedge	35
2	downy brome	0
	fringe sagebrush	85
	junegrass	0
	needleandthread	5
	sun sedge	10
3	downy brome	0
	needleandthread	20
	sun sedge	5
4	downy brome	0
	fringe sagebrush	100
	Kentucky bluegrass	0
	needleandthread	0
	sun sedge	35
	whorled milkweed	100
5	downy brome	0
	needleandthread	15
	wheatgrass	30
	whorled milkweed	0
6	downy brome	0
	Kentucky bluegrass	0
	needleandthread	5
	sun sedge	20
7	downy brome	0
	fringe sagebrush	15
	needleandthread	10
	scarlet globemallow	100
	wheatgrass	20
8	downy brome	0
	needleandthread	0
	wheatgrass	15
9	blackroot	0
	downy brome	0
	needleandthread	5
10	downy brome	0
10	needleandthread	10
	sand dropseed	40
11	downy brome	0
	Kentucky bluegrass	0
	needleandthread	5
	Virginia groundcherry	100
	wheatgrass	20
12	downy brome	0
	needleandthread	15
	sand dropseed	60
	sun sedge	20
13	downy brome	0
	western ragweed	0
14	downy brome	0
	needleandthread	0
	scarlet globemallow	35
15	downy brome	0
	fringe sagebrush	80
	needleandthread	5
	scarlet globemallow	45
	sun sedge	20
16	downy brome	0
	junegrass	0
	needleandthread	25
	sand dropseed	40
	sun sedge	15
17	downy brome	0
	fringe sagebrush	35
	needleandthread	5
	scarlet globemallow	50
	sun sedge	60
18	downy brome	0
	needleandthread	5
	sun sedge	10
19	downy brome	0
	needleandthread	5
	Virginia groundcherry	45
20	downy brome	0
	Kentucky bluegrass	0
	sand dropseed	70
	sun sedge	30

Appendix A4 continued. Vegetation frequency and percent green-up data.

Smiley Canyon Windmill Transect 3 – 3/7/07

Plot #	Plant Name	Green up
1	wheatgrass	95
2	sun sedge	15
	wheatgrass	5
	yucca	100
3	moss	90
	prairie sandreed	0
	sun sedge	30
4	Kentucky bluegrass	20
	prairie sandreed	0
	sand bluestem	0
5	cudweed sagewort	0
	prairie sandreed	0
6	Kentucky bluegrass	10
	prairie sandreed	0
	sun sedge	30
7	Kentucky bluegrass	5
	prairie sandreed	5
8	downy brome	0
	Kentucky bluegrass	5
	Potenilla spp.	85
	sand dropseed	0
	wheatgrass	5
9	wheatgrass	5
10	sand dropseed	0
	wheatgrass	0
11	needleandthread	0
	Potenilla spp.	90
	sand dropseed	0
	wheatgrass	0
12	fringe sagebrush	40
	goat's beard	0
	needleandthread	0
	wheatgrass	0
	whorled milkweed	0
13	goat's beard	0
	Kentucky bluegrass	5
	wheatgrass	0
14	downy brome	0
	sun sedge	30
	wheatgrass	5
15	sand dropseed	0
	sun sedge	35
	wheatgrass	5
16	annual sunflower	0
	downy brome	10
	Potenilla spp.	100
	yucca	50
17	downy brome	5
	wheatgrass	5
18	downy brome	20
	sand dropseed	0
	wheatgrass	0
19	needleandthread	0
	sand dropseed	0
	sun sedge	10
20	downy brome	5
	false boneset	0
	Kentucky bluegrass	0
	sun sedge	10

Appendix A4 continued. Vegetation frequency and percent green-up data.

Smiley Canyon Windmill Transect 3 – 5/19/07

Plot #	Plant Name	Green up
1	alfalfa	100
	wheatgrass	100
2	downy brome	100
	peppergrass	100
	puccoon	100
	sun sedge	100
	wheatgrass	100
	annual mustard	100
3	downy brome	100
	fringe sagebrush	100
	scarlet globemallow	100
	Japenese brome	100
	wheatgrass	100
4	downy brome	100
	goat's beard	100
	puccoon	100
	sun sedge	100
	wheatgrass	100
5	sun sedge	100
	wheatgrass	100
6	Kentucky bluegrass	100
	prairie sandreed	45
	sun sedge	100
	wheatgrass	100
7	Kentucky bluegrass	100
	prairie sandreed	40
	scarlet globemallow	100
	sun sedge	100
8	cudweed sagewort	100
	fringe sagebrush	100
	prairie sandreed	60
	sand bluestem	100
	sixweeks fescue	100
	sun sedge	100
9	Kentucky bluegrass	100
	prairie sandreed	70
	wheatgrass	100
10	goat's beard	100
	Kentucky bluegrass	100
	prairie sandreed	80
	sun sedge	100
11	needleandthread	100
	shelleaf pestemon	100
	sun sedge	100
	wheatgrass	100
12	Kentucky bluegrass	100
	wheatgrass	100
13	Kentucky bluegrass	100
	puccoon	100
	sun sedge	100
	wheatgrass	100
	whorled milkweed	100
14	sun sedge	100
	Japenese brome	100
	wheatgrass	100
15	goat's beard	100
	Kentucky bluegrass	80
	sun sedge	100
	Japenese brome	100
16	sun sedge	100
	wheatgrass	100
17	fringe sagebrush	100
	Japenese brome	100
	wheatgrass	100
18	downy brome	100
	Japenese brome	100
	wheatgrass	100
19	downy brome	100
	sun sedge	100
	Japenese brome	100
	wheatgrass	100
20	fringe sagebrush	100
	sun sedge	100
	wheatgrass	100

Appendix A4 continued. Vegetation frequency and percent green-up data.

Smiley Canyon Windmill Transect 3 – 7/19/07

Plot #	Plant Name	Green up
1	Virginia groundcherry	100
	western ragweed	100
	wheatgrass	60
2	downy brome	0
	sun sedge	5
	wheatgrass	10
	white aster	0
3	downy brome	0
	fringe sagebrush	100
	Japanese brome	0
	western ragweed	20
	wheatgrass	15
4	fringe sagebrush	80
	needleandthread	0
	sun sedge	5
	wheatgrass	70
5	Kentucky bluegrass	0
	prairie sandreed	100
	sun sedge	15
	white aster	0
6	cudweed sagewort	100
	Kentucky bluegrass	0
	prairie sandreed	100
	sand bluestem	0
7	cudweed sagewort	100
	Japanese brome	0
	Kentucky bluegrass	0
	prairie sandreed	100
	sun sedge	10
8	needleandthread	5
	prairie sandreed	90
	sun sedge	5
	wheatgrass	85
9	needleandthread	10
	sun sedge	5
	wheatgrass	20
	white aster	60
10	needleandthread	5
	sun sedge	0
	wheatgrass	65
11	Kentucky bluegrass	0
	needleandthread	25
	Scribner's panicum	100
	sun sedge	5
	wheatgrass	20
12	fringe sagebrush	100
	sun sedge	25
	wheatgrass	65
	whorled milkweed	100
13	Japanese brome	0
	junegrass	0
	needleandthread	0
	Scribner's panicum	100
	sun sedge	5
	western ragweed	0
	wheatgrass	40
	whorled milkweed	100
14	Japanese brome	0
	Kentucky bluegrass	0
	wheatgrass	15
15	Japanese brome	0
	needleandthread	10
	Scribner's panicum	95
	sun sedge	0
	wheatgrass	10
16	Japanese brome	0
	needleandthread	15
	Scribner's panicum	100
	sun sedge	5
	wheatgrass	15
17	Japanese brome	0
	needleandthread	0
	Scribner's panicum	100
	sixweeks fescue	0
	wheatgrass	60
18	Japanese brome	0
	needleandthread	0
	Scribner's panicum	100
	sixweeks fescue	0
	Virginia groundcherry	0
19	downy brome	0
	Japanese brome	0
	needleandthread	0
	sun sedge	45
	wheatgrass	40
	white aster	0
20	Japanese brome	0
	needleandthread	15
	sun sedge	25
	wheatgrass	75

Appendix A4 continued. Vegetation frequency and percent green-up data.

Smiley Canyon Windmill Transect 3 – 10/17/07

Plot #	Plant Name	Green up
1	sun sedge	15
	wheatgrass	10
2	downy brome	0
	sun sedge	15
3	downy brome	0
	fringe sagebrush	85
	needleandthread	10
	western ragweed	0
4	Kentucky bluegrass	0
	needleandthread	15
	prairie sandreed	5
	sun sedge	20
5	Kentucky bluegrass	0
	prairie sandreed	10
	sun sedge	30
	wheatgrass	25
	whorled milkweed	20
6	Kentucky bluegrass	0
	prairie sandreed	15
	sun sedge	20
7	Kentucky bluegrass	0
	needleandthread	5
	prairie sandreed	15
	sand dropseed	45
	sun sedge	10
	white aster	15
8	fringe sagebrush	85
	needleandthread	0
	prairie sandreed	5
	sand dropseed	65
	sun sedge	10
	white aster	65
	woolly plantain	0
9	needleandthread	10
	sand dropseed	35
	whorled milkweed	15
10	Kentucky bluegrass	0
	little bluestem	5
	wheatgrass	25
11	Kentucky bluegrass	0
	needleandthread	5
	western ragweed	0
12	fringe sagebrush	80
	needleandthread	10
13	Kentucky bluegrass	0
	needleandthread	10
	sand dropseed	45
	white aster	20
14	downy brome	0
14	fringe sagebrush	75
	needleandthread	5
	sun sedge	10
15	downy brome	0
	needleandthread	5
	pricklypear cactus	90
	sixweeks fescue	0
	sun sedge	5
	wheatgrass	10
16	downy brome	0
	sand dropseed	65
	sun sedge	10
	wheatgrass	25
17	downy brome	0
	fringe sagebrush	95
	needleandthread	35
	wheatgrass	15
18	downy brome	0
	needleandthread	10
	Virginia groundcherry	90
	wheatgrass	15
19	downy brome	0
	fringe sagebrush	95
	needleandthread	5
	sand dropseed	25
20	downy brome	0
	needleandthread	10
	sun sedge	5

Appendix A5. 2006 and 2007 bite count results.

Spring 2006 (April–May 2006),
14 bite counts total (13 Ewes, 1 Lamb)

Plant Name	Ewe	Lamb
wheatgrass spp.	50%	-
blackroot	32%	100%
fringed sagebrush	9%	-
phlox.	8%	-
yucca	1%	-

Summer 2006 (June-August 2006),
28 bite counts total (20 Ewes, 8 Lambs)

Plant Name	Ewe	Lamb
sweetclover	17%	50%
chokecherry	14%	-
yucca	14%	-
Russian thistle	11%	-
gayfeather	9%	-
blackroot	7%	-
prostrate knotweed	7%	17%
white aster	5%	24%
white prairieclover	4%	-
prickly lettuce	3%	-
prairie sandreed	2%	7%
thistle	2%	-
false solomonseal	1%	-
goat's beard	1%	-
horseweed	1%	-
virginia groundcherry	1%	-
wavyleaf thistle	1%	-
western ragweed	1%	-
hairy goldaster	-	3%
slimflower scurfpea	trace	-
sunflower	-	trace

Appendix A5 continued. 2006 and 2007 bite count results.

Fall 2006 (September-November 2006),
26 bite counts total (16 Ewes, 10 Lambs)

Plant Name	Ewe	Lamb
downy brome	34%	37%
white aster	20%	25%
whorled milkweed	18%	-
phlox	10%	-
chokecherry	8%	-
hairy goldaster	5%	-
blackroot	2%	2%
needleandthread	2%	-
wheatgrass	1%	10%
cudweed sagewort	-	trace
gayfeather	-	trace
junegrass	-	10%
Kentucky bluegrass	-	16%

Winter 2006 (December 2006-January 15, 2007 because of re-collaring effort),
18 bite counts total (8 ewes, 10 lambs)

Plant Name	Ewe	Lamb
downy brome	78%	70%
phlox	14%	18%
wheatgrass	8%	3%
blackroot	-	2%
dog's-tooth-violet	-	trace
shelleaf penstomen	-	7%

Appendix A5 continued. 2006 and 2007 bite count results.

2006 yearly total (from April 2006-January 15, 2007)
84 bite counts total (57 ewes, 27 lambs)

Plant Name	Ewe	Lamb
downy brome	24%	42%
wheatgrass spp.	12%	5%
blackroot	9%	5%
chokecherry	7%	-
white aster	7%	11%
sun sedge	6%	7%
whorled Milkweed	6%	-
sweetclover	5%	10%
yucca	4%	-
gayfeather	3%	trace
Russian Thistle	3%	-
fringed sagebrush	2%	trace
hairy goldaster	2%	1%
phlox	2%	-
prostrate knotweed	2%	3%
needleandthread	1%	-
prairie Sandreed	1%	1%
prickly lettuce	1%	-
thistle	1%	-
white prairieclover	1%	-
cudweed sagewort	-	trace
Erythronuim spp.	-	trace
false solomonseal	trace	-
goat's beard	trace	-
horseweed	trace	-
junegrass	-	3%
Kentucky bluegrass	-	6%
shelleaf penstomen	-	3%
slimflower scurfpea	trace	-
sunflower	-	trace
Virginia groundcherry	trace	-
western ragweed	trace	-

Spring 2007 (May 2007 because of effects from re-collaring effort),
3 bite counts total (3 Ewes, 0 Lambs)

Plant Name	Ewe	Lamb
phlox	44%	-
puccoon	40%	-
alfalfa	15%	-
goldenrod spp.	1%	-
blackroot	-	-
Wheatgrass spp.	-	-

Appendix A5 continued. 2006 and 2007 bite count results.

Summer 2007 (June-August 2007),
29 bite counts total (11 Ewes, 11 Lambs)

Plant Name	Ewe	Lamb
white aster	28%	38%
yucca	24%	11%
prostrate knotweed	13%	-
hairy goldaster	10%	-
milkvetch	8%	-
phlox	6%	7%
sweetclover	6%	-
bastard toadflax	3%	-
whorled milkweed	2%	5%
alfalfa	-	14%
blackroot	-	4%
fleabane	-	13%
goat's beard	-	-
lambs quarter	-	-
prairieclover	-	8%
pricklypear cactus fruit	trace	-
sand dropseed	-	-

Fall 2007 (September-November 2007)
20 bite counts total (10 Ewes, 10 Lambs)

Plant Name	Ewe	Lamb
blackroot	23%	25%
wheatgrass spp.	23%	10%
whiteaster	14%	18%
winter wheat	13%	14%
goldenrod spp.	9%	-
hairy goldaster	7%	15%
poison ivy	6%	-
Russian thistle	5%	trace
milkvetch	-	1%
puccoon	-	-
snowberry	-	7%
sun sedge	-	10%

Winter 2007 (December 2007 - February 2008)
12 bite counts (5 Ewes, 7 Lambs)

Plant Name	Ewe	Lamb
blackroot	60%	75%
fringed sagebrush	30%	15%
wheatgrass spp.	8%	5%
needleandthread	2%	5%

Appendix A5 continued. 2006 and 2007 bite count results.

2007 yearly total (May 2007 through February 2008)
57 bite counts (29 Ewes, 28 Lambs)

Plant Name	Ewe	Lamb
blackroot	18%	33%
white aster	14%	18%
yucca	10%	3%
wheatgrass spp.	9%	6%
hairy goldaster	7%	6%
phlox	6%	2%
fringed sagebrush	5%	4%
prostrate knotweed	5%	-
milkvetch	4%	1%
winter wheat	4%	6%
goldenrod spp.	3%	-
pucoon	3%	-
poison ivy	2%	-
Russian thistle	2%	trace
sweetclover	2%	-
alfalfa	1%	4%
bastard toadflax	1%	-
whorled milkweed	1%	1%
needleandthread	0%	1%
fleabane	-	4%
goat's beard	-	-
lamb's quarter	-	-
prairieclover	-	2%
pricklypear cactus fruit	trace	-
sand dropseed	-	-
snowberry	-	3%
sun sedge	-	4%

Appendix A6. 2006 fecal sample results.

Spring ewe fecal results

Plant species	Average percent relative Density
Carex	24%
Artemisia frigida	15%
Stipa comata	15%
Bouteloua-Sporobolus type	10%
Agropyron	3%
Koeleria	3%
Bromus	3%
unknown forb I	3%
Poa	3%
Ambrosia psilostachya	3%
Dalea	2%
Cirsium	2%
Prunus virginiana	2%
Yucca glauca	2%
Pinus type	1%
Salix type	1%
Artemisia ludoviciana	1%
Artemisia	1%
Chrysopsis villosa	1%
Lesquerella type	1%
seed	6%
Liatris punctata	1%
unknown forb II	trace
Psoralea	trace
Phlox	trace
Gilia type	trace
Opuntia type	trace

Appendix A6 continued. 2006 fecal sample results.

Summer ewe fecal results

Plant species	Average percent relative Density
Bouteloua-Sporobolus type	32%
Stipa comata	12%
Carex	8%
Koeleria	6%
Ambrosia psilostachya	6%
Yucca glauca	4%
Sphaeralcea type	4%
Agropyron	3%
seed	3%
Artemisia frigida	2%
Bromus	2%
unknown forb I	2%
Chrysopsis villosa	2%
Poa	2%
Phlox	1%
Artemisia ludoviciana	1%
Pinus type	1%
Prunus	1%
flower	1%
Salix type	1%
Zexmenia type	1%
Cirsium	1%
Moss	1%
Lesquerella type	1%
Dalea	1%
Prunus virginiana	trace
composite seed	trace
Shepherdia-Eleagnus type	trace
grass seed and glume	trace
unknown grass I	trace
Cirsium undulatum	trace
Penstemon	trace
Polygonum aviculare	trace
Helianthus annuus	trace
Opuntia type	trace
Artemisia	trace
Lactuca serriola	trace
Gilia type	trace
Liatris punctata	trace

Appendix A6 continued. 2006 fecal sample results.

Fall ewe fecal results

Plant species	Average percent relative Density
Stipa comata	26%
Artemisia ludoviciana	18%
Carex	10%
Bouteloua-Sporobolus type	9%
Yucca glauca	6%
Artemisia frigida	5%
Poa	3%
Agropyron	3%
Chrysopsis villosa	3%
Sphaeralcea type	2%
seed	2%
Bromus	2%
Koeleria	2%
Helianthus annuus	2%
unknown forb I	1%
Cirsium undulatum	1%
Pinus type	1%
unknown grass I	1%
Salsola iberica	1%
Psoralea	1%
Lesquerella type	trace
Dalea	trace
Artemisia tridentata type	trace
composite seed	trace
grass seed and glume	trace
Shepherdia-Eleagnus type	trace
unknown forb III	trace
flower	trace
Artemisia	trace
Opuntia type	trace
Phlox	trace
Zexmenia type	trace
Physalis	trace
Draba type	trace
Prunus	trace
corn kernel	trace

Appendix A6 continued. 2006 fecal sample results.

Winter ewe fecal results

Plant species	Average percent relative Density
Artemisia ludoviciana	39%
Stipa comata	12%
Artemisia frigida	9%
Yucca glauca	8%
Poa	6%
Carex	4%
Bouteloua-Sporobolus type	4%
Pinus type	3%
Zexmenia type	3%
Agropyron	3%
Bromus	2%
Chrysopsis villosa	2%
Artemisia	1%
Helianthus annuus	1%
Lesquerella type	1%
Koeleria	1%
Dalea	1%
unknown grass I	1%
Sphaeralcea type	1%
unknown forb I	trace
seed	trace
Salsola iberica	trace
Shepherdia-Eleagnus type	trace

Appendix A6 continued. 2006 fecal sample results.

Yearly ewe fecal results

Plant species	Average percent relative Density
Stipa comata	17%
Bouteloua-Sporobolus type	16%
Artemisia ludoviciana	15%
Carex	9%
Artemisia frigida	6%
Yucca glauca	5%
Koeleria	3%
Sphaeralcea type	3%
Poa	3%
Agropyron	3%
Ambrosia psilostachya	2%
Bromus	2%
Chrysopsis villosa	2%
seed	2%
unknown forb I	1%
Pinus type	1%
unknown grass I	1%
Helianthus annuus	1%
Dalea	1%
Lesquerella type	1%
Phlox	1%
Cirsium undulatum	trace
flower	trace
Cirsium	trace
Salix type	trace
Prunus	trace
Artemisia	trace
Prunus virginiana	trace
Salsola iberica	trace
composite seed	trace
Zexmenia type	trace
grass seed and glume	trace
Shepherdia-Eleagnus type	trace
Psoralea	trace
Moss	trace
unknown forb III	trace
Artemisia tridentata type	trace
Opuntia type	trace
Sitanion hystrix type	trace
Liatris punctata	trace
Penstemon	trace
Polygonum aviculare	trace
unknown forb II	trace
Gilia type	trace
Physalis	trace

Appendix A6 continued. 2006 fecal sample results.

Yearly ewe fecal results continued

Plant species	Average percent relative Density
Draba type	trace
Lactuca serriola	trace
corn kernel	trace

Summer lamb fecal results

Plant species	Average percent relative Density
Bouteloua-Sporobolus type	35%
Carex	8%
Stipa comata	8%
Ambrosia psilostachya	7%
Koeleria	6%
Artemisia ludoviciana	6%
Artemisia frigida	5%
Chrysopsis villosa	5%
Sphaeralcea type	3%
Agropyron	3%
seed	2%
Yucca glauca	2%
Bromus	1%
unknown forb I	1%
Poa	1%
Shepherdia-Eleagnus type	1%
Cirsium	1%
Pinus type	1%
Zexmenia type	1%
Cirsium undulatum	1%
composite seed	trace
Dalea	trace
Helianthus annuus	trace
Prunus	trace
flower	trace
Grass seed and glume	trace
Salsola iberica	trace
Lesquerella type	trace
Salix type	trace
Moss	trace
Tragopogon dubius	trace
Liatris punctata	trace
Artemisia	trace
Phlox	trace
Prunus virginiana	trace

Appendix A6 continued. 2006 fecal sample results.

Fall lamb fecal results

Plant species	Average percent relative Density
Stipa comata	22%
Artemisia ludoviciana	15%
Bouteloua-Sporobolus type	12%
Carex	10%
Artemisia frigida	6%
Yucca glauca	5%
Chrysopsis villosa	5%
Agropyron	4%
Poa	3%
Koeleria	2%
Bromus	2%
seed	2%
Sphaeralcea type	2%
Helianthus annuus	2%
Cirsium undulatum	1%
unknown grass I	1%
Pinus type	1%
Lesquerella type	1%
Dalea	trace
unknown forb I	trace
grass seed and glume	trace
composite seed	trace
unknown forb III	trace
Artemisia	trace
Draba type	trace
Prunus virginiana	trace
Ambrosia psilostachya	trace
flower	trace
unknown forb II	trace
Lactuca serriola	trace
Polygonum aviculare	trace
Sitanion hystrix type	trace
Artemisia tridentata type	trace

Appendix A6 continued. 2006 fecal sample results.

Winter lamb fecal results

Plant species	Average percent relative Density
Artemisia ludoviciana	30%
Yucca glauca	14%
Artemisia frigida	14%
Stipa comata	13%
Poa	6%
Carex	6%
Bouteloua-Sporobolus type	3%
Agropyron	3%
Bromus	2%
Pinus type	1%
Koeleria	1%
Artemisia	1%
Chrysopsis villosa	1%
Helianthus annuus	1%
Dalea	1%
Salsola iberica	1%
Sphaeralcea type	1%
unknown grass I	1%
unknown forb I	trace
seed	trace
Zexmenia type	trace
Phlox	trace
Psoralea	trace
unknown forb II	trace

Appendix A6 continued. 2006 fecal sample results.

Yearly lamb fecal results

Plant species	Average percent relative Density
Bouteloua-Sporobolus type	17%
Stipa comata	16%
Artemisia ludoviciana	15%
Carex	9%
Artemisia frigida	7%
Yucca glauca	6%
Chrysopsis villosa	4%
Agropyron	3%
Poa	3%
Koeleria	3%
Ambrosia psilostachya	2%
Sphaeralcea type	2%
Bromus	2%
seed	2%
Helianthus annuus	1%
Pinus type	1%
Cirsium undulatum	1%
unknown forb I	1%
unknown grass I	1%
Dalea	1%
Lesquerella type	trace
Shepherdia-Eleagnus type	trace
composite seed	trace
Artemisia	trace
grass seed and glume	trace
Cirsium	trace
Salsola iberica	trace
Zexmenia type	trace
flower	trace
unknown forb III	trace
Prunus	trace
Prunus virginiana	trace
Draba type	trace
Phlox	trace
unknown forb II	trace
Salix type	trace
Moss	trace
Tragopogon dubius	trace
Lactuca serriola	trace
Liatris punctata	trace
Polygonum aviculare	trace
Sitanion hystrix type	trace
Psoralea	trace
Artemisia tridentata type	trace

Appendix A7. Vegetation survey charts.

Mexican Canyon top

Plant Name	Averaged Frequency
downy brome	**68%**
sun sedge	**48%**
needleandthread	**45%**
prairie sandreed	**41%**
western ragweed	**37%**
Kentucky bluegrass	**31%**
Japanese brome	**27%**
wheatgrass	**26%**
blackroot	**22%**
white aster	**20%**
fringed sagebrush	**19%**
sand bluestem	**19%**
scarlet gaura	**14%**
Junegrass	**12%**
hairy goldaster	**11%**
sideoats grama	**10%**
blue grama	**8%**
goat's beard	**8%**
skeletonweed	**8%**
smooth brome	**7%**
puccoon	**7%**
sand dropseed	**6%**
Wilcox panicum	**4%**
little bluestem	**4%**
Rockymountain beeplant	**4%**
yucca	**4%**
goldenrod	**3%**
pricklypear cactus	**3%**
spiderwort	**3%**
whorled milkweed	**3%**
wild rose	**3%**
American vetch	**2%**
peppergrass	**2%**
purple prairieclover	**2%**
Shinneroseris rostrata	**2%**
Texas Croton	**2%**
woolly plantain	**2%**
brittle cactus	**1%**
cudweed sagewort	**1%**
dandelion	**1%**
deathcamas	**1%**
desert stickseed	**1%**
hawk's beard	**1%**
horseweed	**1%**
phlox	**1%**
primrose spp.	**1%**
sand sagebrush	**1%**
shelleaf penstomon	**1%**
silverleaf scurfpea	**1%**
skunkbrush sumac	**1%**
slimflower scurfpea	**1%**
Virginia groundcherry	**1%**

Appendix A7 continued. Vegetation survey charts.

Mexican Canyon hillside

Plant Name	Averaged Frequency
sun sedge	**41%**
downy brome	**35%**
wheatgrass	**31%**
sideoats grama	**30%**
white aster	**29%**
fringed sagebrush	**28%**
needleandthread	**26%**
Kentucky bluegrass	**21%**
goldenrod	**17%**
chokecherry	**16%**
cudweed sagewort	**14%**
desert stickseed	**13%**
golden pea	**13%**
blackroot	**12%**
Rockymountain beeplant	**12%**
Field chickweed	**11%**
snowberry	**10%**
prairie sandreed	**10%**
skunkbrush sumac	**8%**
Japanese brome	**8%**
Hairy goldaster	**8%**
Junegrass	**7%**
wild rose	**7%**
puccoon	**7%**
scarlet gaura	**7%**
unknown forb A8	**7%**
yucca	**7%**
poison ivy	**6%**
Sand bluestem	**5%**
tumble mustard	**5%**
plains mughly	**5%**
annual sunflower	**4%**
rock cress	**4%**
textile onion	**4%**
western ragweed	**4%**
crazyweed	**3%**
smooth brome	**3%**
broom snakeweed	**3%**
peppergrass	**3%**
unknown forb 2	**3%**
unknown forb 3	**3%**
blue grama	**2%**
dandelion	**2%**
gayfeather	**2%**
goat's beard	**2%**
lambstoungue groundsel	**2%**
prairie milkvetch	**2%**
pricklypear cactus	**2%**
Shinneroseris rostrata	**2%**
spiderwort	**2%**
unknown forb 1	**1%**
bergamat	**1%**
blue-eyed grass	**1%**
hare bell	**1%**
horseweed	**1%**
phlox	**1%**
purple prairieclover	**1%**
sand dropseed	**1%**
sego lily	**1%**
silverleaf pladderpod	**1%**
skeletonweed	**1%**
white beardstongue	**1%**

Appendix A7 continued. Vegetation survey charts.

Smiley Canyon top

Plant Name	Averaged Frequency
sun sedge	**48%**
Kentucky bluegrass	**45%**
needleandthread	**33%**
smooth brome	**33%**
wheatgrass	**25%**
Junegrass	**24%**
fringed sagebrush	**23%**
prairie sandreed	**23%**
white aster	**20%**
little bluestem	**19%**
downy brome	**18%**
western ragweed	**16%**
blackroot	**14%**
puccoon	**11%**
skeletonweed	**10%**
goat's beard	**10%**
golden pea	**9%**
American licorice	**8%**
peppergrass	**8%**
sideoats grama	**8%**
blue grama	**6%**
prairie thermopsis	**6%**
sand bluestem	**6%**
Candadian thistle	**5%**
desert stickseed	**5%**
field chickweed	**5%**
gayfeather	**5%**
hairy goldaster	**4%**
sixweeks fescue	**4%**
snowberry	**4%**
scarlet globemallow	**4%**
brittle cactus	**3%**
dandelion	**3%**
goldenrod	**3%**
phlox	**3%**
scarlet gaura	**3%**
spiderwort	**3%**
hare bell	**1%**
Japanese brome	**1%**
pricklypear cactus	**1%**
primrose spp.	**1%**
purple prairieclover	**1%**
rock cress	**1%**
Shinneroseris rostrata	**1%**
silverleaf scurfpea	**1%**
textile onion	**1%**
thistle spp.	**1%**
unknown forb 8	**1%**
yarrow	**1%**
yucca	**1%**

Appendix A7 continued. Vegetation survey charts.

Smiley Canyon hillside

Plant Name	Averaged Frequency
sun sedge	**54%**
white aster	**53%**
goldenrod	**46%**
hairy goldaster	**38%**
fringed sagebrush	**36%**
golden pea	**34%**
needleandthread	**34%**
snowberry	**29%**
field chickweed	**26%**
smooth brome	**25%**
wheatgrass	**25%**
gayfeather	**22%**
Kentucky bluegrass	**20%**
puccoon	**19%**
hare bell	**15%**
Junegrass	**15%**
yucca	**13%**
prairie thermopsis	**11%**
blackroot	**10%**
downy brome	**8%**
western ragweed	**8%**
poison ivy	**5%**
prairie sandreed	**5%**
sideoats grama	**5%**
unknown forb 8	**5%**
crazyweed	**4%**
false boneset	**4%**
wild rose	**4%**
American vetch	**4%**
broom snakeweed	**4%**
American licorice	**3%**
little bluestem	**3%**
rock cress	**3%**
Rockymountain beeplant	**3%**
skunkbrush sumac	**3%**
annual mustard	**1%**
curlycup gumweed	**1%**
dandelion	**1%**
ground plum	**1%**
pasque flower	**1%**
peppergrass	**1%**
pricklypear cactus	**1%**
silverleaf pladderpod	**1%**
sixweeks fescue	**1%**
spiderwort	**1%**
unknown forb A8	**1%**

Smiley Canyon windmill roadside

Plant Name	Averaged Frequency
downy brome	**89%**
wheatgrass	**73%**
Japanese brome	**31%**
sun sedge	**29%**
needleandthread	**29%**
western ragweed	**23%**
scarlet globemallow	**21%**
Virginia groundcherry	**16%**
skeletonweed	**16%**
tumble mustard	**14%**
Sweetclover	**14%**
peppergrass	**11%**
sand dropseed	**6%**
puccoon	**5%**
Shinneroseris rostrata	**5%**
white aster	**5%**
goat's beard	**5%**
cudweed sagewort	**5%**
smooth brome	**5%**
scarlet gaura	**4%**
fringed sagebrush	**4%**
Kentucky bluegrass	**3%**
alfalfa	**3%**
Russian thistle	**3%**
little bluestem	**2%**
annual mustard	**2%**
annual sunflower	**2%**
prairie sandreed	**1%**
blackroot	**1%**
shelleaf penstomon	**1%**
spiderwort	**1%**

Appendix A7 continued. Vegetation survey charts.

Smiley Canyon windmill middle

Plant Name	Averaged Frequency
downy brome	**60%**
sun sedge	**58%**
needleandthread	**56%**
Japanese brome	**43%**
wheatgrass	**41%**
Kentucky bluegrass	**36%**
western ragweed	**30%**
scarlet globemallow	**20%**
fringed sagebrush	**15%**
sand dropseed	**13%**
Scribners panicum	**11%**
puccoon	**10%**
Junegrass	**9%**
Virginia groundcherry	**8%**
shelleaf penstomon	**6%**
sweetclover	**6%**
white aster	**6%**
sixweeks fescue	**4%**
annual sunflower	**3%**
blackroot	**3%**
blue grama	**3%**
goat's beard	**3%**
little bluestem	**3%**
prairie sandreed	**3%**
tumble mustard	**3%**
whorled milkweed	**3%**
woolly plantain	**3%**
yucca	**3%**
annual mustard	**1%**
Shinneroseris rostrata	**1%**
smooth brome	**1%**
texas Croton	**1%**

Smiley Canyon windmill butteside

Plant Name	Averaged Frequency
wheatgrass	**64%**
sun sedge	**58%**
needleandthread	**38%**
Kentucky bluegrass	**31%**
downy brome	**29%**
prairie sandreed	**24%**
Japanese brome	**19%**
fringed sagebrush	**18%**
sand dropseed	**15%**
white aster	**9%**
whorled milkweed	**8%**
Scribners panicum	**8%**
goat's beard	**6%**
western ragweed	**6%**
sixweeks fescue	**5%**
cudweed sagewort	**4%**
sand bluestem	**4%**
Virginia groundcherry	**4%**
cinqefoil spp.	**4%**
puccoon	**4%**
annual sunflower	**3%**
scarlet globemallow	**3%**
alfalfa	**1%**
annual mustard	**1%**
false boneset	**1%**
Junegrass	**1%**
little bluestem	**1%**
peppergrass	**1%**
pricklypear cactus	**1%**
shelleaf penstomon	**1%**
woolly plantain	**1%**
yucca	**1%**

Appendix A7 continued. Vegetation survey charts.

Lover's Leap hillside

Plant Name	Averaged Frequency
blackroot	**80%**
Junegrass	**49%**
needleandthread	**44%**
fringed sagebrush	**41%**
downy brome	**40%**
western ragweed	**36%**
Japanese brome	**32%**
Kentucky bluegrass	**29%**
prairie sandreed	**20%**
yucca	**17%**
wheatgrass	**15%**
American vetch	**15%**
sand sagebrush	**15%**
scarlet globemallow	**14%**
white aster	**13%**
silverleaf scurfpea	**12%**
goat's beard	**11%**
whorled milkweed	**8%**
woolly plantain	**8%**
blue grama	**8%**
smooth brome	**6%**
pricklypear cactus	**6%**
horseweed	**5%**
peppergrass	**5%**
slimflower scurfpea	**5%**
brittle cactus	**5%**
tumble mustard	**4%**
dandelion	**3%**
sideoats grama	**3%**
skeletonweed	**3%**
spiderwort	**3%**
puccoon	**2%**
rock cress	**2%**
sand bluestem	**2%**
sand dropseed	**2%**
sixweeks fescue	**2%**
yarrow	**2%**
hairy goldaster	**1%**
little bluestem	**1%**
phlox	**1%**
primrose spp.	**1%**
shelleaf penstomon	**1%**
unknown forb 3	**1%**

Saddle Rock hillside

Plant Name	Averaged Frequency
sideoats grama	**45%**
desert stickseed	**35%**
wheatgrass	**33%**
needleandthread	**30%**
fringed sagebrush	**29%**
downy brome	**28%**
yucca	**17%**
scarlet gaura	**15%**
silverleaf scurfpea	**15%**
Russian thistle	**14%**
blue grama	**13%**
tumble mustard	**10%**
blackroot	**9%**
peppergrass	**9%**
western ragweed	**9%**
prairie sandreed	**7%**
spiderwort	**7%**
broom snakeweed	**5%**
sand dropseed	**5%**
bush morningglory	**4%**
horseweed	**3%**
little bluestem	**3%**
sand bluestem	**3%**
snowberry	**3%**
sweetclover	**3%**
gayfeather	**2%**
Japanese brome	**2%**
lamb's quarters	**2%**

Appendix A7 continued. Vegetation survey charts.

Saddle Rock Flats valley

Plant Name	Averaged Frequency
blackroot	**60%**
fringed sagebrush	**50%**
needleandthread	**48%**
Japanese brome	**37%**
Junegrass	**34%**
downy brome	**29%**
whorled milkweed	**23%**
Kentucky bluegrass	**22%**
yucca	**22%**
scarlet globemallow	**19%**
sand sagebrush	**18%**
prairie sandreed	**17%**
wheatgrass	**16%**
blue grama	**13%**
puccoon	**12%**
woolly plantain	**11%**
white aster	**10%**
pricklypear cactus	**8%**
sun sedge	**7%**
goat's beard	**4%**
rock cress	**4%**
hawk's beard	**3%**
horseweed	**3%**
peppergrass	**3%**
sand bluestem	**3%**
sand dropseed	**3%**
western ragweed	**3%**
western wallflower	**3%**
gayfeather	**2%**
silverleaf scurfpea	**2%**
spiderwort	**2%**
American vetch	**1%**
brittle cactus	**1%**
deathcamas	**1%**
desert stickseed	**1%**
goldenrod	**1%**
ground plum	**1%**

Saddle Rock Flats bottom

Plant Name	Averaged Frequency
needleandthread	**63%**
downy brome	**60%**
blackroot	**60%**
Kentuck bluegrass	**36%**
Japanese brome	**28%**
wheatgrass	**27%**
yucca	**22%**
Junegrass	**20%**
prairie sandreed	**18%**
blue grama	**18%**
sand sagebrush	**11%**
goat's beard	**10%**
western ragweed	**9%**
whorled milkweed	**8%**
skeletonweed	**7%**
woolly plantain	**7%**
sand bluestem	**7%**
brittle cactus	**6%**
scarlet globemallow	**6%**
peppergrass	**5%**
bush morningglory	**4%**
horseweed	**4%**
pricklypear cactus	**3%**
puccoon	**3%**
sixweeks fescue	**3%**
sand dropseed	**3%**
scarlet gaura	**2%**
thistle spp.	**2%**
dandelion	**2%**
shelleaf penstomon	**2%**
sideoats grama	**2%**
cudweed sagewort	**1%**
desert stickseed	**1%**
flax spp.	**1%**
hoary vervain	**1%**
mullein	**1%**
primrose spp.	**1%**
Shinneroseris rostrata	**1%**
smooth brome	**1%**

Appendix A8. Home Range charts.

Adaptive Kernel Model Year 1 (2006)

ID	n	href	h adhoc	h	Adap0.95	Adap0.5	Adaptive_Tin_95SA
Green 1	36	0.550	0.6	0.330	34.8	3.4	36.3
Red 28	34	0.556	0.5	0.278	37.1	5.6	38.5
Green 12	53	0.516	0.6	0.310	47.6	4.5	49.3
Green 13	58	0.508	0.6	0.305	42.5	4.9	43.8
Green 14	63	0.501	0.7	0.351	52.4	8.3	54.1
Green 18	66	0.497	0.7	0.348	52.5	6.7	53.9
Green 19	38	0.545	0.7	0.382	43.2	7.9	44.3
Green 2	61	0.504	0.7	0.353	50.9	8.3	52.5
Green 20	34	0.556	0.8	0.444	62.9	10.9	64.6
Green 22	47	0.526	0.5	0.263	27.7	4.5	28.7

Fixed Kernel Model Year 1 (2006)

ID	n	href	h adhoc	h	Fixed95	Fixed50	Fixed_Tin_95SA
Green 1	36	0.550	0.7	0.385	27.9	5.3	28.9
Red 28	34	0.556	0.5	0.278	30.0	6.4	31.0
Green 12	53	0.516	0.7	0.361	38.5	6.5	39.7
Green 13	58	0.508	0.7	0.356	37.9	7.5	38.9
Green 14	63	0.501	0.7	0.351	44.1	10.3	45.6
Green 18	66	0.497	0.8	0.398	45.7	9.3	47.5
Green 19	38	0.545	0.7	0.382	37.2	9.0	38.5
Green 2	61	0.504	0.7	0.353	43.4	9.8	45.1
Green 20	34	0.556	0.8	0.444	51.6	12.4	53.3
Green 22	47	0.526	0.6	0.316	26.9	6.6	27.8

Adaptive Kernel Model Year 2 (2007)

ID	n	href	h adhoc	h	Adap0.95	Adap0.5	Adaptive_Tin_95SA
Green 1	43	0.534	0.4	0.214	44.6	7.8	46.3
Red 5	39	0.543	0.8	0.434	42.5	3.6	44.1
Red 28	24	0.589	0.6	0.353	38.5	4.7	40.0
Green 12	52	0.518	0.8	0.414	50.0	7.4	51.5
Green 13	49	0.523	0.7	0.366	50.7	8.7	52.4
Green 14	48	0.525	0.7	0.367	53.0	7.5	54.4
Green 15	40	0.541	0.7	0.379	52.3	9.8	54.0
Green 18	41	0.539	0.6	0.323	50.0	9.0	51.6
Green 19	41	0.539	0.9	0.485	54.9	7.7	56.6
Green 2	57	0.510	0.8	0.408	52.5	9.1	122.5
Green 20	40	0.541	1	0.541	55.9	8.2	57.7
Green 22	48	0.525	0.5	0.262	55.3	8.4	57.3
Green 23	49	0.523	0.5	0.261	46.5	6.7	48.0
Green 7	55	0.513	0.9	0.462	53.3	7.6	54.7
Green 8	45	0.530	0.7	0.371	55.8	10.4	57.5
Green 9	46	0.528	0.6	0.317	44.4	9.2	45.8

Appendix A8 continued. Home Range charts.

Fixed Kernel Model Year 2 (2007)

ID	n	href	h adhoc	h	Fixed95	Fixed50	Fixed_Tin_95SA
Green 1	43	0.534	0.5	0.267	45.0	10.9	54.9
Red 5	39	0.543	1	0.543	34.8	6.2	36.5
Red 28	24	0.589	0.7	0.412	33.4	7.2	34.9
Green 12	52	0.518	0.9	0.466	45.2	9.9	46.8
Green 13	49	0.523	0.8	0.418	49.8	12.0	51.6
Green 14	48	0.525	0.8	0.420	47.4	10.6	49.1
Green 15	40	0.541	0.7	0.379	46.3	11.4	48.0
Green 18	41	0.539	0.7	0.377	51.9	12.3	53.8
Green 19	41	0.539	1	0.539	44.5	9.5	46.0
Green 2	57	0.510	0.9	0.459	50.1	11.4	91.7
Green 20	40	0.541	1	0.541	41.7	9.3	42.6
Green 22	48	0.525	0.6	0.315	52.4	11.5	54.5
Green 23	49	0.523	0.6	0.314	44.5	9.8	46.2
Green 7	55	0.513	1	0.513	46.0	10.1	47.4
Green 8	45	0.530	0.7	0.371	49.9	12.3	51.1
Green 9	46	0.528	0.7	0.370	46.5	12.1	48.2

Adaptive Kernel Model Both Years

ID	n	href	h adhoc	h	Adap0.95	Adap0.5	Adaptive_Tin_95SA
Green 1	79	0.483	0.5	0.241	47.9	4.8	49.9
Red 28	58	0.508	0.5	0.254	36.1	5.4	47.7
Green 12	105	0.460	0.7	0.322	45.7	5.1	47.5
Green 13	107	0.459	0.7	0.321	45.6	6.2	47.3
Green 14	111	0.456	0.7	0.319	50.6	7.0	52.5
Green 18	107	0.459	0.7	0.321	51.5	7.7	53.4
Green 19	79	0.483	0.8	0.386	49.2	8.1	51.0
Green 2	118	0.452	0.7	0.316	45.9	7.6	47.7
Green 20	74	0.488	0.8	0.390	53.7	9.2	55.5
Green 22	95	0.468	0.5	0.234	46.2	6.0	48.1
Herd	1252	0.305	0.9	0.274	47.4	6.8	48.9

Fixed Kernel Model Both Years

ID	n	href	h adhoc	h	Fixed95	Fixed50	Fixed_Tin_95SA
Green 1	79	0.483	0.6	0.290	40.7	7.8	42.5
Red 28	58	0.508	0.6	0.305	33.4	7.5	34.9
Green 12	105	0.460	0.8	0.368	39.3	7.3	41.0
Green 13	107	0.459	0.8	0.367	42.1	9.1	43.8
Green 14	111	0.456	0.8	0.365	45.3	10.0	47.1
Green 18	107	0.459	0.7	0.321	43.4	9.3	45.3
Green 19	79	0.483	1	0.483	48.9	11.3	50.7
Green 2	118	0.452	0.8	0.361	43.6	10.0	45.4
Green 20	74	0.488	1	0.488	47.6	11.0	49.4
Green 22	95	0.468	0.6	0.281	41.7	8.4	43.4
Herd	1252	0.305	1	0.305	41.9	9.2	43.5

Appendix A8 continued. Home Range charts.

Minimum Convex Polygon Method

	Year 1		Year 2		Both Years	
Individual	**n**	**95MCP**	**n**	**95MCP**	**n**	**95MCP**
Green 1	36	14.8	43	33.5	79	34.0
Red 5			39	16.2		
Red 28	34	19.8	24	15.1	58	21.6
Green 12	53	29.3	52	22.9	105	30.6
Green 13	58	23.7	49	23.4	107	26.4
Green 14	63	29.9	48	26.4	111	32.1
Green 15			40	20.5		
Green 18	66	30.0	41	24.8	107	36.7
Green 19	38	19.0	41	20.6	79	26.6
Green 2	61	26.6	57	29.7	118	33.0
Green 20	34	29.9	40	19.6	74	26.5
Green 22	47	27.3	48	37.1	95	31.1
Green 23			49	28.8		
Green 7			55	24.6		
Green 8			45	27.1		
Green 9			46	25.8		
Herd					1252	38.6

Appendix A9. Klinksiek's data.

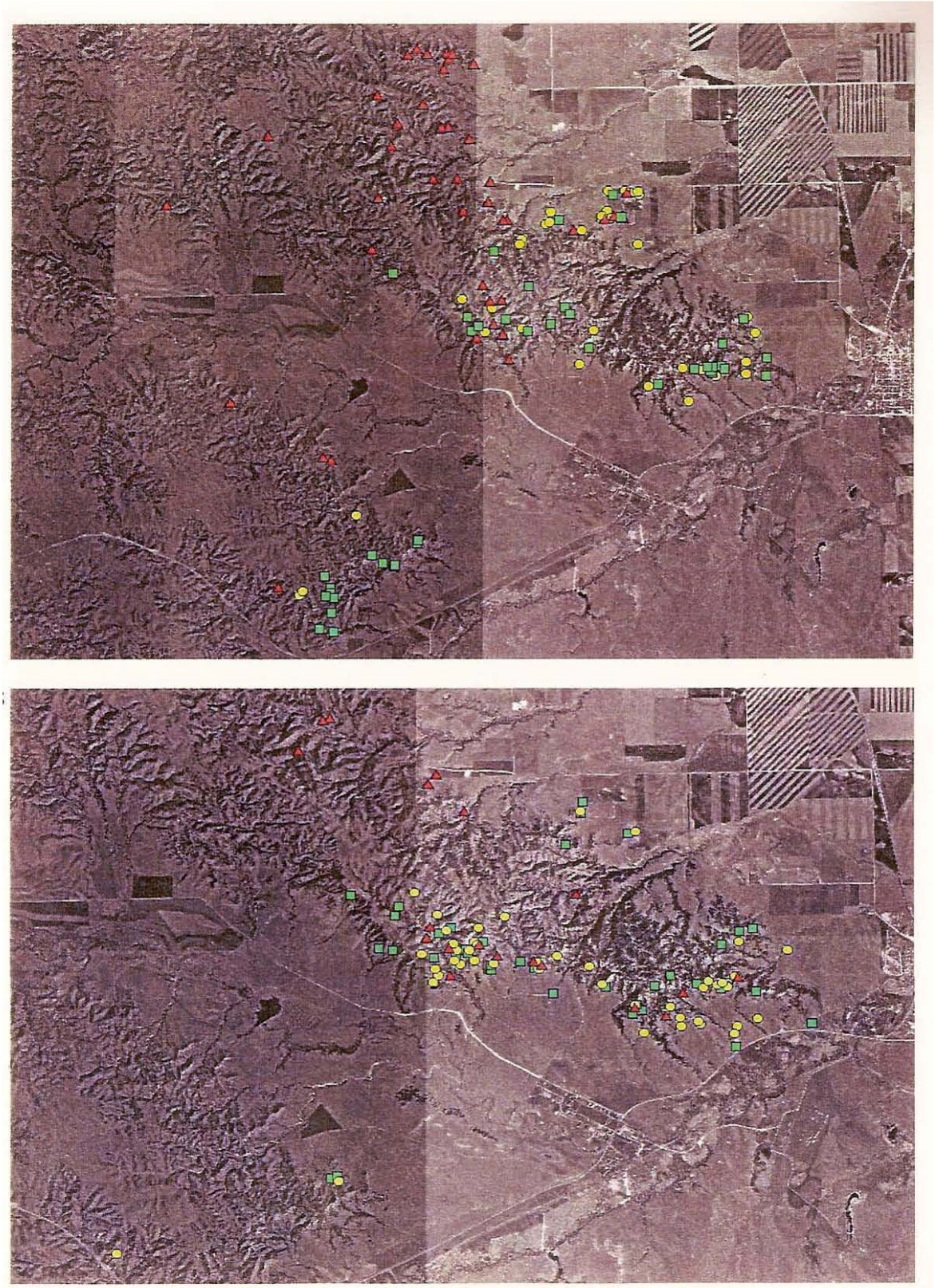

Figure 2. Winter locations of male (red triangles), female (green squares), and mixed-sex groups (yellow circles) during 2002 (A) and 2003 (B).

Appendix A9 continued. Klinksiek's data.

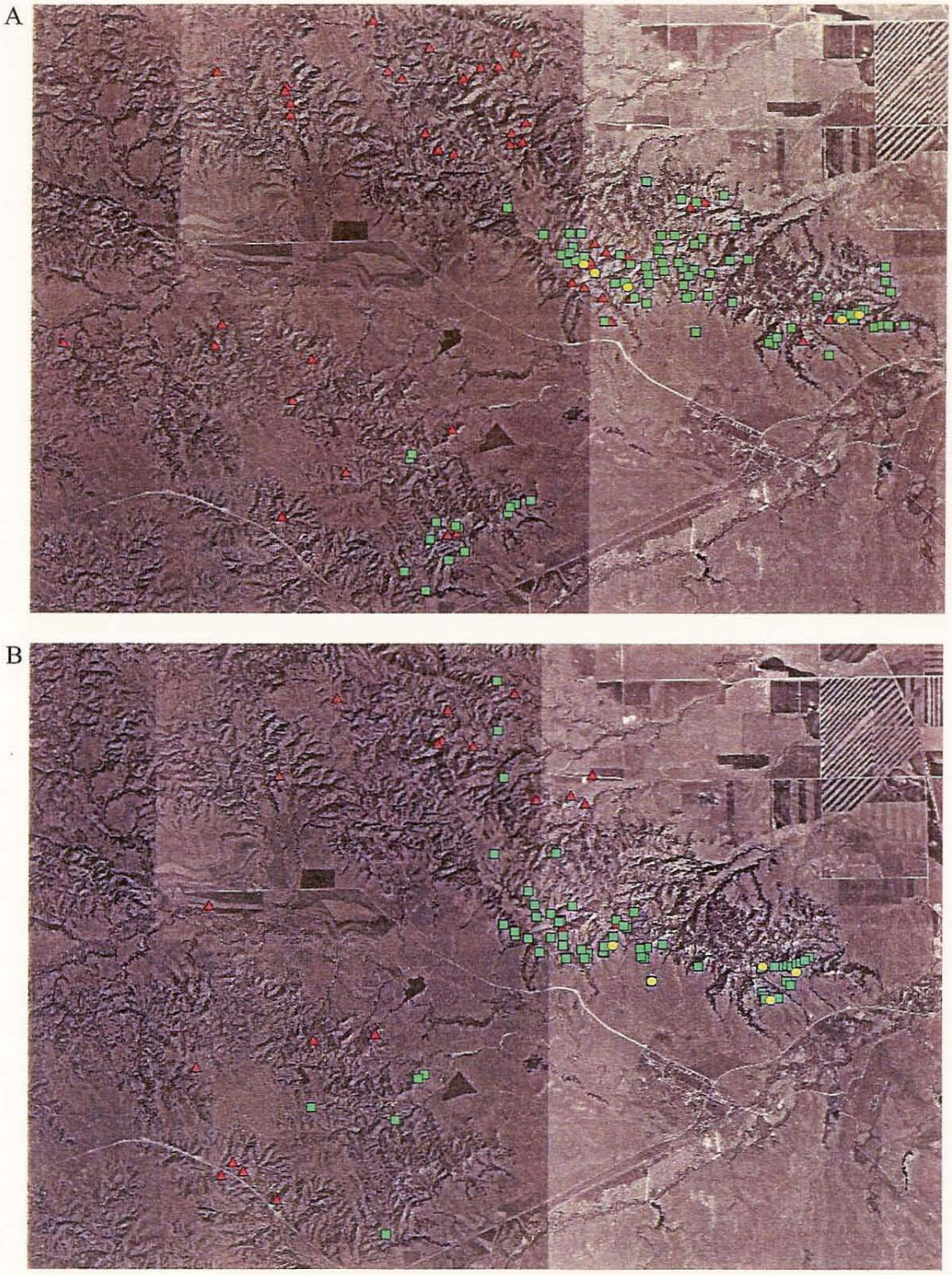

Figure 3. Spring locations of male (red triangles), female (green squares), and mixed-sex groups (yellow circles) during 2002 (A) and 2003 (B).

Appendix A9 continued. Klinksiek's data.

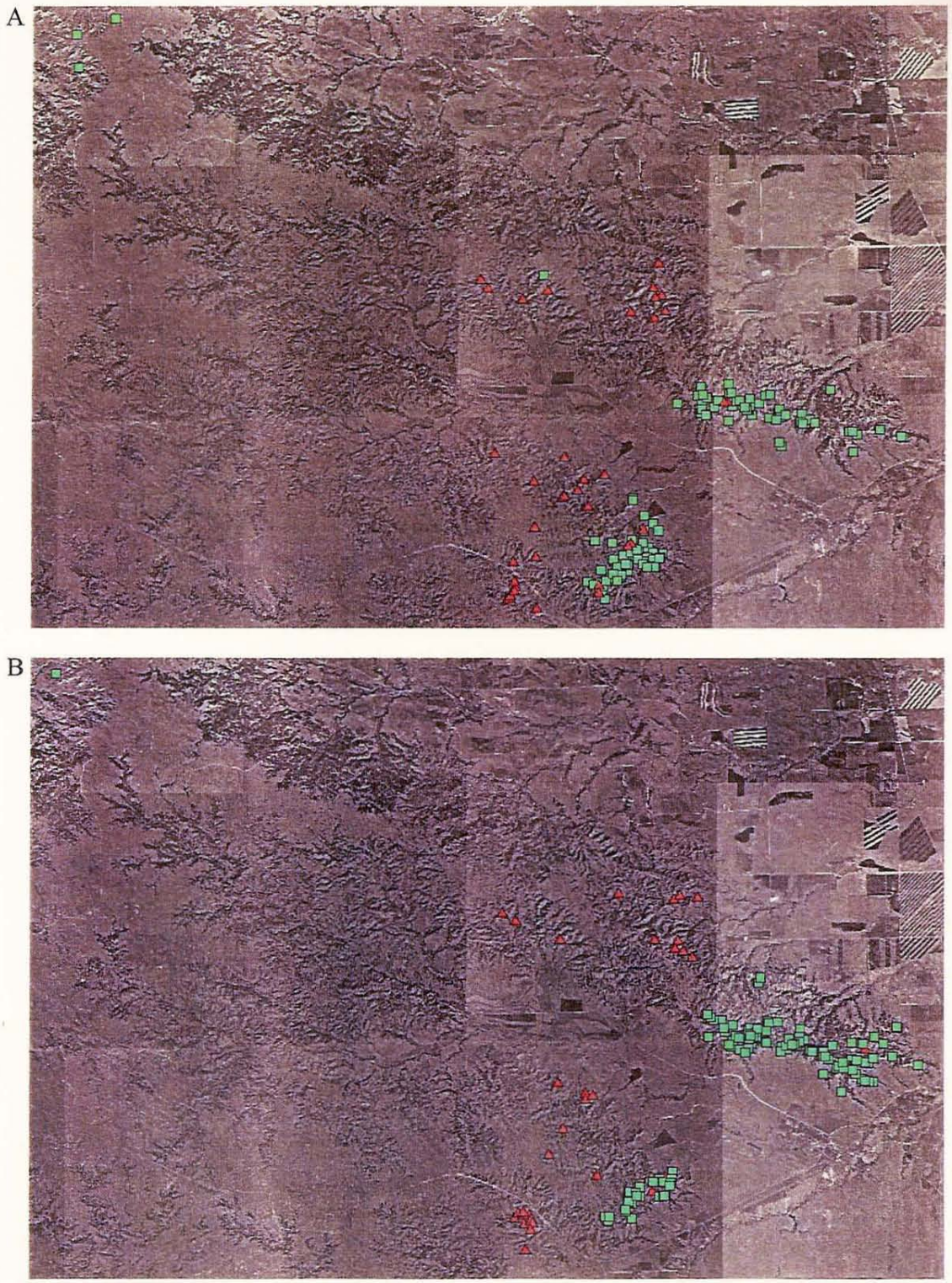

Figure 4. Summer locations of male (red triangles) and female (green squares) groups during 2002 (A) and 2003 (B).