Five Year Summary of Vegetation and Soil Surveys on the Montana Allotment, Chilton Ranch, Arivaca, Arizona
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and

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Summary

1. Rangeland ecological condition on the Montana Allotment is late-seral or good. Midgrasses have been replacing shortgrasses based our quantitative and qualitative monitoring over the last 6 years. Sideoats grama is the primary midgrass in all pastures.
2. Four key areas on Schumacher Pasture were evaluated for vegetation composition changes between 1998 and 2003. These key areas showed a definite upward trend is occurring in Schumacher Pasture.
3. Forage production across 15 sites on the Montana Allotment averaged 1200 lbs per acre in October of 2003. This is 20% higher than in 1999.
4. Grazing use across Montana Allotment pastures has averaged 20% (light) over the last 6 years.
5. Grazing use across Montana Allotment pastures in 2003 averaged 19% or light. Grazing use on grazed pastures was 29% or light.
6. Riparian health on the Montana Allotment has been rated excellent based on a quantitative survey conducted in 2000 by Dr. William Fleming, a hydrologist with the University of New Mexico.
7. Soil health on the Montana Allotment is rated excellent based on a variety of qualitative and quantitative surveys. In 2002 an intensive study of sediment accumulation in 10 ponds showed erosion across the Montana Allotment was at the natural rate.
8. A total of 13 livestock water developments have been added to the Montana Allotment since 1998. This has greatly improved livestock distribution and reduced the proportion of heavily grazed rangelands.

9. Precipitation at Arivaca, Arizona has been 104% of the long-term average for the 1998–2003 period. However, for the years 2001–2003, precipitation was only 79% of the long-term average. In 2003 precipitation was 92% of the long-term average.

10. Over the 1998-2003 period, the Montana Allotment carried an average of 427 animal units. During this period, forage use on grazed pastures averaged 29%. Based on these data, the Montana Allotment could have safely carried 589 cattle without causing a downward trend or exceeding the Forest Service guideline of 45% (moderate grazing).

11. The Montana Allotment is a major range management success story that has been well documented by monitoring from Forest Service range personnel and private range consultants. This success is attributed to light stocking rates, a rest rotation grazing system, intensive monitoring coupled with adaptive management, and practices to improve livestock distribution that included water development, fence additions, and herding.

12. The Montana Allotment has probably been more intensively monitored than any piece of grazing land in the western United States. Jim Chilton has used monitoring information to quickly respond to changing climatic and vegetation condition. We believe this to be an important reason for his management success.

Introduction

On October 15, 2003, Dr. Jerry Holechek and Dr. Dee Galt were formally contacted by the Chilton Ranch and Cattle Company regarding updating and summarizing vegetation and soil data they had collected over the past 5 years from spring 1998 to autumn 2003 on Schumacher, Ruby, Warsaw, Chimenea and Bolsa pastures on their ranch. These pastures are part of the Montana Allotment under grazing permit issued by the U.S. Forest Service, and are south of Arivaca, Arizona near the Mexican border. The primary purpose of our field survey and summary would be to evaluate changes in rangeland ecological condition on Schumacher Pasture within the Montana Allotment. We also were requested to assess rangeland and soil conditions across the allotment.

We (Holechek and Galt) accepted the assignment. On October 3, 2003 we arrived at the Chilton Ranch headquarters. On October 3-4 and October 24-26, 2003 we conducted surveys of Warsaw, Chimenea, Bolsa and Schumacher pastures with the aid of Jim and Sue Chilton. On October 24, 2003, Mr. Keith Graves (Nogales District Ranger) and Mr. Kendall Brown (range conservationist) of the U.S. Forest Service accompanied us on our surveys of the Montana Allotment. Quantitative data on rangeland ecological condition were collected in Schumacher Pasture using procedures of the USDA – Natural Resources Conservation Service. These data were collected on 4 key areas and compared to data collected in 1998 for an evaluation of trend in ecological condition. Forage production across the Montana Allotment was also evaluated. This report also contains a summary of grazing intensity, riparian, and soil surveys conducted on the Montana Allotment during 1998 – 2003 period.

Montana Allotment and Chilton Ranch Description

The portion of the Chilton Ranch we have surveyed (Montana Allotment) is on the Coronado National Forest in the Nogales Ranger District in the Atascosa/Pajarito mountains west of Nogales, Arizona. This portion of the ranch includes Schumacher, Ruby, Ruby Trap, Warsaw, Chimenea and Bolsa pastures and excludes the Lake, House, Yellow Jacket and Mare pastures. Elevations range from 3,500 feet at the Mexican border to 5,376 feet at the summit of Montana peak. Annual precipitation varies from 17–22 inches in Warsaw pasture. The pattern of precipitation is bimodal with peaks in winter (February) and summer (August) and a dry period in spring (April through June). Total precipitation from Nov. 1, 2002 to Nov. 1, 2003 was 98% of the average (Table 1). Precipitation in 2003 was below average in winter/spring, but well above average in the summer. We characterize the vegetation as Sonoran Desert Chaparral/Grassland.

Dominant plant species include various liveoaks (*Quercus emoryi, Quercus oblongifolia)* various cacti (*Ferocactus wislizenii, Opuntia engelmannii, Fouquieria splendens*), plains lovegrass (*Eragrostis intermedia*), sideoats grama (*Bouteloua curtipendula*), green sprangletop (*Leptochloa dubia*) cane beardgrass (*Bothriochloa barbinodis*), and tanglehead (*Heteropogon contortus*). In riparian areas, deergrass (*Muhlenbergia rigens*), bullgrass (*Muhlenbergia emersleyi*), and giant sacaton (*Sporobolus wrightii*) are dominant grasses, while ashes (*Fraxinus* sp.) and several willows (*Salix gooddingiim, S. taxifolia, S. Bonplandiana*) and cottonwoods (*Populus* sp.) are present. Plant species diversity is quite high.

Several important game animals are found on the survey pastures. They include white-tailed deer, mule deer, cougar, javelina, Mearn's quail, Gambel's quail, white-winged doves and mourning doves. Most of California Gulch is usually dry during the months of April-June and

long reaches are dry most of the year except following periods of heavy rainfall. It should be noted that the three pastures (Schumacher, Ruby, Warsaw) have very high esthetic value and receive considerable recreational use by campers and hunters.

Mining activity occurs throughout the study pastures, but has had greatest impact in Schumacher pasture. Here, considerable disturbance of soil has resulted from recent road building activities associated with mining operations. To some extent this has impaired esthetic value of the pasture, has increased erosion potential and may be a threat to water quality.

Based on information from the Forest Service (File Code 2100), the Montana Allotment (Chimenea, Bolsa, Ruby, Ruby Trap, and Warsaw pastures) is now permitted for 400-500 animal units (cow-calf) for year-long use. The Montana Allotment involves 21,430 acres with 11,550 suitable acres after correction for slope and distance from water using Holechek et al. (2004) procedures. In general, the Montana Allotment is well watered and adequately capitalized with roads, fences and corrals for efficient livestock production.

Hereford-Brahman crossbred cows that are well adapted to local terrain and climate, are grazed on the Montana Allotment. These cows are bred to Red Angus bulls. Calf crops average about 80% and calf weaning weights average 525 pounds. No supplemental feeding has been used. Annual calf crops are reduced 5 to 10% by predation, primarily from mountain lions, depending upon drought conditions affecting deer populations and steadily increasing mountain lion populations.

The Chilton's have owned the Montana Allotment for over 10 years (since April 1991). Mr. Jim Chilton grew up on a ranch in Arizona and has had considerable cattle ranching experience. He holds a M.S. degree in economics and a Master of Arts in political science. Mrs. Sue Chilton currently serves as a State Game and Fish Commissioner.

Grazing management on the Montana Allotment involves a modification of the Santa Rita rest rotation grazing system discussed by Martin (1978). This system was initiated on the Montana Allotment in the 1989-90 period after a six year period of fence building and water development. Under the system used on the Montana Allotment, Schumacher and Warsaw pastures receive four months of summer grazing followed by a 20-month rest period. Ruby pasture receives light transient use in the fall of every year as cattle are drifted through it to winter range in Chimenea pasture. Ruby pasture is grazed in the spring of each year. Chimenea pasture is grazed every year from October to mid April.

Methodology

We have conducted a wide variety of vegetation and soil surveys on the Montana Allotment that involve nearly every aspect of rangeland health. These past surveys have heavily focused on rangeland ecological condition, rangeland trend, grazing intensity and grazing capacity. These are the 4 primary surveys most used to judge range management effectiveness. They are discussed in detail by Holechek et al. (2004). Additional surveys involving riparian health (Fleming et al. 2001), watershed health (Fleming and Holechek 2002), and soil health (Fleming et al. 2003) have been conducted on the Montana Allotment. We will specifically discuss methodologies for our surveys conducted in autumn 2003 that are not available in other reports. In past and present our basic procedures for evaluating ecological condition have followed Dyksterhuis (1949). Our basic procedures for evaluating rangeland trend have followed Holechek et al. (2004). Our basic procedures for evaluating grazing intensity have followed Anderson and Currier (1973) and Holechek and Galt (2000).

On October 24 and 25, 2003 we collected quantitative information on rangeland ecological condition in Schumacher Pasture at three upland key areas and one riparian key area

using the Dyksterhuis (1949) approach. A 100 meter transect was used for these surveys. At one meter increments, a 0.75 inch loop was used to quantify vegetation cover. The nearest plant was recorded for determination of vegetation composition. Mrs. Sue Chilton and Dr. Dee Galt identified plants while Dr. Jerry Holechek recorded observations. Dr. Dee Galt has considerable experience with vegetation in the area (he conducted range research on the Santa Rita Range near Tucson). Guidelines provided by the USDA-Natural Resources Conservation Service were used to classify rangeland ecological condition. Mr. and Mrs. Chilton served as guides for the survey and provided transportation.

We closely followed procedures of Holechek and Galt (2000) in our grazing intensity survey of Warsaw Pasture. This procedure involves averaging grazing intensity estimates from cages, visual appearance, and stubble heights to determine percent forage use at each key area.

The key areas – weight estimate procedure developed by Holechek (1988) was used to intensively evaluate forage production and grazing capacity on the Montana Allotment in February 2000 (Galt and Holechek 2000). We selected 2–4 key areas considered to be representative of individual pastures for our more limited survey on October 24 – 26, 2003. Ten $2.4ft^2$ plots were systematically selected and evaluated at each key area. All forage production data were converted to a dry matter basis.

Results and Discussion

Precipitation

Across the 6 year period (1998-2003) that we have monitored vegetation and soil conditions on the Montana Allotment, annual precipitation at Arivaca, Arizona has averaged 18.64 inches. This is 104% of the long-term average (17.86 inches) (Table 1). Three years (1999, 2001, 2003) were near average, two years were well above average (1998, 2000), and one

year involved severe drought (2002). In 2003 both growing season (97% of average) and total annual precipitation (92% of average) were slightly below average. However, growing season precipitation was well timed, the rainfall events were closely spaced, and the rains tended to be of low intensity. These factors are all conducive to perennial grass growth. On the other hand total 2002 precipitation was only 45% of the long-term average. It was the worst drought year of the last 50 years (Table 1). Growing season precipitation in 2002 was 53% of the long-term average. Previous year and current year precipitation both strongly influence current year forage production in southern Arizona (Cable and Martin 1975). After taking these various factors into account we believe that perennial grass growing conditions were about 85% of the hypothetical average. In other words, if forage production were estimated at 1,000 lbs/ac., it would be adjusted to 1,176 lbs/ac. for carrying capacity estimates.

Generally because of the dry conditions of the last 3 years (79% of average precipitation) a downward or stable trend in rangeland ecological condition is expected based on research reviewed by Holechek et al. (2004). This means some precipitation-related replacement of midgrasses by shortgrasses on the Montana Allotment would be expected to occur. The primary purpose of our surveys in October 2003 was to evaluate vegetative responses to management practices on the Montana Allotment. Consideration of recent precipitation conditions is essential in interpreting our data on vegetation composition and forage production.

Rangeland Condition and Trend

Our 4 key areas on Schumacher Pasture had an average ecological condition score of 60% climax vegetation on October 25, 2003 (Table 2). This equates to a late-seral stage or good condition rangeland. Two key areas were in late-seral condition, one key area was in climax condition, and one key area was in mid-seral condition.

On the upper key area an exotic plant, natal grass has invaded the site. We omitted natal grass from determinations of plant composition in 1998 and 2003. Apparently natal grass was seeded by Forest Service personnel in the 1980's along some of the roads used for mining operations to aid in erosion control.

On the drainage key area, the west 30 meters of the transect have been impacted by vehicle activity. We omitted this distance from our transect in calculating ecological condition score in 1998 and 2003.

Our comparisons of rangeland ecological condition between 1998 and 2003 on the Montana Allotment show a definite upward trend (Table 2, Appendix Tables 1, 2, 3, 4). Two sites showed improvement and two sites were stable (Table 2). A 5% or more change in range condition score indicates a definite upward or downward trend (Holechek et al. 2004). One half or more of the key areas on an allotment or pasture need to have an upward trend for the pasture to be considered improving (Holechek et al. 2004). These criteria were met in Schumacher Pasture. Therefore we consider Schumacher Pasture to be in an upward trend.

Both our quantitative and visual observations show a definite shift from shortgrasses to midgrasses is occurring across the Montana Allotment. We have observed this shift on all pastures and it was pronounced in our autumn 2003 surveys. We believe this shift is due primarily to the light stocking rates, the rest rotation grazing system, and cattle distribution practices (fencing, water development, herding) that have been aggressively applied by Mr. Jim Chilton over the past 12 years.

Midgrasses that are noticeably more prevalent now than in 1998 across the Montana Allotment are sideoats grama, plains lovegrass, and green sprangletop. These grasses, all considered decreasers, are highly valued for their productivity and palatability to livestock.

However, they have low grazing resistance and become less prevalent and gradually disappear under heavy use.

Forage Production

Forage production across the Montana Allotment in October 2003 averaged 555 lbs/per acre on shortgrass sites, 1,427 lbs/per acre on midgrass sites and 1,911 lbs per acre on drainage/riparian sites. Across all 15 sites forage production averaged 1200 lbs per acre. In winter 2000 when we conducted our intensive survey of grazing capacity on the Montana Allotment, forage production averaged 986 lbs per acre. These data indicate forage production may have increased about 20 to 30% on the Montana Allotment over the last 4 years when drought conditions are taken into account. This would mean the grazing capacity of the Montana Allotment has increased somewhere between 100 and 150 animal units above the 559 animal units that it was estimated to safely carry in 2000 (see Galt and Holechek 2000). We recognize the limited number of sites we evaluated in October 2003 limits drawing definite conclusions. However, it may be worthwhile to repeat the grazing capacity survey if precipitation conditions are near normal in 2004. We do believe the increased forage production we have observed in 2003 is due primarily to a shift from shortgrasses to midgrasses rather than to superior growing conditions (see discussion of precipitation).

A climax midgrass plant community with exceptional vigor was measured within 30 meters of Japanese Tank, a major water on Ruby Pasture (Appendix Table 7). This is compelling evidence of the effectiveness of the grazing management program on the Montana Allotment.

Grazing Intensity

Across the 6 years (1998–2003) of our intensive surveys, grazing use on the Montana

Allotment has averaged 20% or light (Table 1, Appendix Table 8). On the grazed pastures grazing use has averaged 29% or light. Grazing intensity across the Montana Allotment was highest in 2000 when use averaged 26%. During the 6 years we have monitored the Montana Allotment, 40% use (conservative grazing) in Chimenea Pasture in April 1998 was the highest grazing intensity recorded.

Various studies reviewed by Holechek et al. (2004) show that light grazing allows forage species to express their productive potential and it maximizes successional advance toward the climax. We believe the light grazing intensities applied across Montana Allotment pastures since 1989 explain in large part the phenomenal shift from shortgrasses to midgrasses and increases in forage production documented by Forest Service range personnel and private range consultants (see Fleming et al. 2001).

Riparian Health

A detailed survey in summer 2000 reported by Fleming et al. (2001) found riparian conditions on the Montana Allotment to be good to excellent (Appendix Table 9). Vegetation diversity, bank stability and streambed geology were considered excellent. Significant numbers of riparian tree recruits were observed. These included various willow species, ash and cottonwoods. Canopy shading and width/depth ratios continue to improve as young riparian trees grown since rest-rotation was implemented move into higher age and size classes. Overall Fleming et al. (2001) considered the Montana Allotment a positive standout among various sites in the southwest they had evaluated that received livestock grazing. They believed the rest rotation grazing system in conjunction with conservative stocking rates largely explained the high level of riparian health on the Montana Allotment.

Soil Health

Qualitative and quantitative surveys across the Montana Allotment have consistently found soil health to be excellent (Fleming et al. 2003). The most comprehensive and quantitative of these surveys was conducted in May 2002 (see Fleming and Holechek 2002, Fleming et al. 2003). This survey evaluated sediment accumulation in 10 ponds of known age (Appendix Table 10). Based on this survey, erosion across the Montana Allotment was at the natural rate. Soil health across the Montana Allotment was rated excellent. No evidence was found of accelerated erosion due to cattle grazing on the Montana Allotment. Some accelerated erosion may be occurring in a few locations due to roads, mining and camping activities. Our various qualitative soil surveys including those in 2003 support and confirm the findings of Dr. William Fleming, who is a respected hydrologist at the University of New Mexico in Albuquerque.

Water and Fence Developments

A total of 13 water developments have been added to the Montana Allotment since 1998 (Table 5, Appendix Table 11). These developments have been quite effective in improving uniformity of grazing use and reducing the proportion of heavily grazed land.

The additions of water developments and fencing have had the greatest impact in Warsaw Pasture. In Warsaw Pasture the addition of a division fence on the west side of the pasture in conjunction with three water developments reduced the proportion of heavily grazed land from 8% in 2001 to 2% in 2003. Overall grazing use of Warsaw Pasture was 31% in 2001 compared to 21% in 2003.

Monitoring and Adaptive Management

The Montana Allotment has probably been more intensively monitored than any piece of grazing land in the western United States. Mr. Jim Chilton has used this information to quickly respond to ever changing climatic and vegetation conditions. Holechek et al. (2004) point out

the critical role that monitoring plays in successful range management. Without question an important part of the success documented on the Montana Allotment is due to the monitoring program coupled with adaptive management applied by Mr. Jim Chilton.

Summary and Conclusions

Our 6 year (1998–2003) summary (see Table 6) of rangeland monitoring on the Montana Allotment shows it to be a definite range management success story. Even though dry conditions have occurred on the Montana Allotment during the last 3 years, rangeland ecological condition and forage production are in a strong upward trend. Ecological condition of the Montana Allotment vegetation is late-seral (good). Midgrasses, primarily sideoats grama, plains lovegrass, and green sprangletop now dominate the allotment compared to shortgrasses 15-20 years ago. Climax midgrass communities showing exceptional vigor were measured and noted immediately adjacent to a major stock water, Japanese Tank, in Ruby Pasture. Riparian and soil health are rated excellent based on various qualitative and quantitative surveys. Grazing intensity levels across the Montana Allotment have consistently been light over the past 6 years. Cattle grazing pressure has been evenly distributed over grazed pastures due to a combination of water development, fencing, and herding. The rest rotation grazing scheme has proved quite effective in providing sensitive areas (drainages, riparian zones) with opportunity to improve. We believe this system also enhances uniformity of livestock distribution in grazed pastures.

Across the 1998-2003 period, cattle numbers on the Montana Allotment averaged 427 (Table 6). During this period forage use on grazed pastures averaged 29% or light. A use level of up to 45% (moderate) is permitted on grazed pastures. On this basis 589 cattle could have safely grazed the Montana Allotment over the 1998-2003 period without harmful effects or exceeding the Forest Service use guideline of 45%. These data are consistent with the grazing

capacity survey by Galt and Holechek (2000) that showed the Montana Allotment would safely support 559 animal units.

The year 2003 was a benchmark for the Montana Allotment due to a major increase in midgrasses after a year of severe drought. Our surveys on the Montana Allotment and research by Holechek et al. (2003) show good grazing management practices can promote improvement in ecological condition in arid and semi-arid areas even when accompanied by drought. An important part of the success on the Montana Allotment is attributed to the rangeland monitoring program and adaptive management approach used by Mr. Jim Chilton.

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Table 1. Precipitation (inches) totals by ten year periods and monthly precipitation for 2000, 2001, 2002, and 2003 for Arivaca, Arizona.

	1956-1959	1960s	1970s	1980s	1990s	2000s
0	--------	19.98	14.28	11.67	22.33	25.05
1	--------	14.48	20.49	17.26	15.26	17.65
2	--------	16.12	15.58	16.67	19.43	8.08
3	--------	15.25	12.77	28.45	27.53	16.48
4	--------	21.13	14.51	27.74	22.63	
5	--------	19.02	11.01	16.87	18.54	
6	8.28	19.31	18.74	16.54	17.30	
7	12.54	20.37	18.68	21.84	16.00	
8	18.67	13.63	24.68	19.83	28.25	
9	16.57	14.51	14.99	11.31	16.35	
$\bar{x}$	14.10	17.38	16.57	18.82	20.29	16.82

	Monthly Precipitation			
	2000	2001	2002	2003
January	0.00	2.50	.25	0.00
February	0.00	0.55	.00	3.15
March	1.20	1.55	.20	0.72
April	0.00	1.45	.00	0.00
May	0.00	0.0	.00	0.45
June	4.75	0.90	.00	0.00
July	0.10	5. 00	2.84	5.30
August	6.95	2.10	2.90	3.51
September	1.15	1.00	0.72	1.45
October	8.90	0.60	0.20	1.90
November	1.75	0. 00	0.32	
December	0.25	2.00	0.65	
Total	25.05	17.65	8.08	16.48

Average/Annual long term precipitation = 17.86 inches.

Table 2. Summary of ecological range condition scores in Schumacher Pasture [1, 2].

Site	F. S. Score (1984)	Site	F. S. Score (1996)	Site	Holechek/Galt Score (1998)	(2003)
C3-1	19	C3	73	Upper	58	56
C3-2	12			Middle	51	59
C3-3	37	P11	68	Lower	46	46
				Drainage	66	77
$\bar{x}$	23		70		55	60

[1)] USDA-Natural Resources Conservation Service Scoring System used for all years.
[2)] Scoring based on USDA-NRCS shallow hills 16-20 inch precipitation zone range site description for 41-1 resource area (from Dan Robinett, Tucson, AZ).

Table 3. Current years growth of forage on Warsaw, Schumacher, Ruby, Chimenea, and Bolsa Pastures of the Montana Allotment in October 2003.

Pasture	Site		
	Shortgrass	Midgrass	Drainage/Riparian
	----------Lbs/acre----------		
Warsaw	600		
Schumacher			
Northeast		605	
Middle		806	
South	460		
Drainage			2,517
Chimenea			
Southwest	317	1,742	
Southeast	738	2,054	
Ruby			
Northeast1		1,456	
Northeast2		1,685	
Japanese Tank			
Upland and Drainage		1,925	1,305
Bolsa			
East		1,147	
West	650		
Average	553	1,427	1,911

Table 4. Summary for data pooled across years and pastures.

Year	Overall Grazing Use (%)		Pasture	Overall Grazing Use (%)	
1998	17%	Light			
1999	16%	Light	Schumacher	18%	Light
2000	26%	Light	Ruby	23%	Light
2001	16%	Light	Warsaw	14%	Light
2002	23%	Light	Bolsa	11%	Light
2003	19%	Light	Chimenea	33%	Conservative
Average	20%	Light	Average	20%	Light

Summary for Grazed Pastures by Year

Year	Grazing Use (%)	
1998	28%	Light
1999	26%	Light
2000	33%	Conservative
2001	27%	Light
2002	29%	Light
2003	29%	Light
Average	29%	Light

Summary for Pastures when Grazed

Pasture	Grazing Use %	
Schumacher	34%	Conservative
Ruby	23%	Light
Warsaw	29%	Light
Bolsa	32%	Conservative
Chimenea	33%	Conservative

Table 5. Summary of water developments on Montana Allotment from 1998 to October 31, 2003.

Pasture	Type of Development
Warsaw	Well – Grubstake Mine Pipeline/Storage tank – Holden Canyon Bentonite existing tank – Holden Canyon Nogalito tank was fenced to control use in the northwestern corner of the pasture and distribute cattle.
Schumacher	Pipeline and a 10,000 gallon storage tank – Schumacher Spring Rebuilt hidden tank in Schumacher
Ruby	Water trough – Eagle tank Trough/Storage tank – Intersection of Schumacher/Warsaw/Ruby Pastures Replaced Pipeline – Figtree Spring
Chimenea	Well/Storage tank – North end
Bolsa	Rebuilt Bolsa tank

Table 6. A summary of precipitation, stocking level, forage production, grazing use, and rangeland ecological condition on the Montana Allotment for the 1998-2003 period.

Characteristic	1998	1999	2000	2001	2002	2003
Precipitation (inches/year)	28	16	25	18	8	16
Actual cattle animal unit numbers	500	476	380	400	380	425
Fall perennial forage standing crop (lbs/acre)	---	986	---	---	---	1200
Forage use % (across all pastures)	17	16	26	16	23	19
Forage use % (grazed pastures)	28	26	33	27	29	29
Rangeland ecological condition scores						
Forest Service sites	---	69	---	---	---	---
Schumacher Pasture sites	55	---	---	---	---	60

Appendix Table 1. Species composition of shallow hills range site in northeast part of Schumacher Pasture.[1, 2]

Plant Species	Percent Composition		Ecological[4] Condition	
	1998	2003	1998	2003
Sprucetop grama	27.0	38.0	3.0	3.0
Sideoats grama	11.0	16.5	11.0	16.5
Plains lovegrass	15.0	5.0	15.0	5.0
Green sprangletop	4.0	6.5	4.0	6.5
Cane beardgrass	10.0	2.5	10.0	2.5
Beggartick Threeawn	0.0	5.0	0.0	5.0
Tanglehead	4.0	2.5	2.0	2.5
[3]Other perennial grasses	12.0	15.5	5.0	6.0
Annual forbs	12.0	0.0	3.0	0.0
Perennial forbs	2.0	1.0	2.0	1.0
Velvet pod mimosa	3.0	5.0	3.0	5.0
Dodonaea spp.	0.0	2.5	0.0	2.5
Total	100.0	100.0	58.0	56.0
Range condition score			58	56
Ecological condition			Good	Good

[1)] Basal hits on nonplants in 1998 were 50% rock and gravel, 11% bare ground and 32% litter. Basal hits in 2003 were 51% rock and gravel, 5% bare ground and 34% litter.

[2)] 100 meter permanent transect was placed across slopes and plant hits were recorded at 1 meter intervals using a Parker ¾ inch loop. Species composition is based on basal hits and nearest plant.

[3)] Other perennial grasses include Texas bluestem, Threeawns, *Muhlenbergia* spp., hairy grama, slender grama, and plains bristlegrass.

[4)] Only plant percentages counted toward ecological condition according to NRCS Range Site Condition Guide, Shallow Hills, 16-20 PZ, Tucson, Arizona.

Appendix Table 2. Species composition of Shallow Hills Range Site at Mid-Schumacher Pasture.[1, 2]

Plant species	Percent Composition		Ecological Condition[4]	
	1998	2003	1998	2003
Sprucetop grama	27.0	28.0	3.0	3.0
Sideoats grama	16.0	23.0	16.0	23.0
Cane Beadgrass	9.0	6.0	9.0	6.0
Hairy grama	7.0	5.0	3.0	5.0
Slender grama	0.0	12.0	0.0	2.0
Green sprangletop	3.0	4.0	3.0	4.0
Tanglehead	3.0	2.0	2.0	2.0
[3]Other perennial grasses	4.0	7.0	2.0	3.0
Annual grasses	1.0	0.0	1.0	0.0
Annual forbs	21.0	0.0	5.0	0.0
Perennial forbs	1.0	2.0	1.0	2.0
Guajilla (Calliandra)	7.0	7.0	5.0	5.0
Velvet pod mimosa	1.0	3.0	1.0	3.0
Cholla	0.0	1.0	0.0	1.0
Total	100.0	100.0	51.0	59.0
Range Condition score			51	59
Ecological condition			Good	Good

[1)] Basal hits on nonplants in 1998 were 33% rock and gravel, 16% bare ground and 28% litter. Basal hits in 2003 were 32% rock and gravel, 15% bare ground and 40% litter.
[2)]100 meter permanent transect was placed across slopes and plant hits were recorded at 1 meter intervals using a Parker ¾ inch loop species composition is based on basal hits and nearest plant.
[3)] Other perennial grasses include curly mesquite, muhly, plains lovegrass, and threeawns.
[4)] Ecological condition is based on NRCS Range Site Guide for Shallow Hills, 16-20 PZ, Tucson, Arizona.

Appendix Table 3. Species Composition of Shallow Hills Range Site near Cluster 3 (U.S. Forest Service) on lower Schumacher Pasture.[1, 2]

Plant species	Percent Composition		Ecological Condition[4]	
	1998	2003	1998	2003
Sprucetop grama	36.0	39.0	3.0	3.0
Sideoats grama	22.0	24.5	22.0	24.5
Plains lovegrass	2.0	0.5	2.0	0.5
Tanglehead	1.5	0.0	1.5	0.0
Santa Rita grama	1.0	0.0	1.0	0.0
Curly mesquite	Trace	3.0	0.0	2.0
Slender tridens	0.0	5.5	0.0	2.0
[3]Other perennial grasses	7.0	2.0	5.0	2.0
Perennial forbs	2.5	1.5	2.5	1.5
Annual forbs	16.0	0.0	3.0	0.0
Guajilla (Calliandra)	10.0	23.0	5.0	10.0
Velvet pod mimosa	1.0	0.0	1.0	0.0
Snakeweed	1.0	0.5	Trace	Trace
Barrel cactus	0.0	0.5	0.0	0.5
Total	100.0	100.0	46.0	46.0
Range Condition score			46	46
Ecological condition			Fair	Fair

[1)] Basal hits on nonplants in 1998 were 50% rock and gravel, 11% bare ground and 32% litter. Basal hits in 2003 were 45% rock and gravel, 19% bare ground and 24% litter.
[2)] Two 100 meter permanent transect were placed across slopes and plant hits were recorded at 1 meter intervals using a Parker ¾ inch loop. Percent composition is an average of two transects by year for this site.
[3)] Other perennial grasses include slender grama, hairy grama, bull muhly, curly mesquite, cane beardgrass, Hall's panic, purple grama, threeawns and aparejo grass.
[4)] Ecological condition is based on NRCS Range Site Guide for Shallow Hills, 16-20 PZ, Tucson, Arizona.

Appendix Table 4. Species composition of riparian site on an intermittent stream tributary into California Gulch on Lower Schumacher Pasture.[1, 2]

Plant species	Percent Composition		Ecological Condition	
	1998	2003	1998	2003
Deergrass	21.5	26.0	21.5	26.0
Sideoats grama	33.0	27.0	33.0	27.0
Green sprangletop	0.0	11.0	0.0	11.0
Bull muhly	0.0	4.5	0.0	4.5
Spruce top grama	1.5	14.5	1.5	3.0
[3]Other perennial species	1.5	1.5	1.5	1.5
Annual grasses	0.0	13.0	0.0	3.0
Annual forbs	27.0	0.0	3.0	0.0
Perennial forbs	6.0	0.0	4.0	0.0
Snakeweed	4.0	1.0	1.0	1.0
Total	100.0	100.0	65.5	77.0

[1)] Basal hits on nonplants in 1998 were 11% rock and gravel, 2% bare ground and 48% litter. Basal hits in 2003 were 12% rock, 17% bare ground and 60% litter.
[2)] A 100 meter permanent transect was placed along intermittent stream and plant hits were recorded at 1 meter intervals using a Parker ¾ inch loop.
[3)] Other species include *Baccharis* spp., plains lovegrass, cane beardgrass and sand dropseed.

Appendix Table 5. Current years growth of forage plants on three upland sites and a riparian site on Schumacher Pasture of the Montana Allotment, Chilton Ranch, October 2003.[1]

Locations	Current year's growth
Uplands	lbs/ac
Northeast	605
Middle	806
South	460
Riparian	
South	2,517

[1)] Production was determined by placing five, 2.4ft^2 quadrats at 20 meter intervals along 100 meter transects.
Forage production surveys were made using the double sampling weight estimate method on key sites. All production data are on a dry matter basis.

Appendix Table 6. Current years growth of forage on pastures of the Montana Allotment rested during the July – October period of the summer growing season of 2003 on the Chilton Ranch, Arivaca, Arizona.

Pastures	Current years growth		
	Key Sites[1, 2]		
	Shortgrass	Midgrass	Riparian
	lbs/ac		
Bolsa	650	1,147	-------
Ruby	-------	1,456	-------
[3]Chimenea (South)			
	317 (Southwest)	1,742	-------
	738 (Southeast)	2,054	-------
Schumacher	460	706	2,517

[1)] Key sites consisted of both shortgrass and midgrass dominance. Primary shortgrasses are sprucetop grama, hairy grama and curly mesquite. Midgrasses are sideoats grama, cane beardgrass, plains lovegrass and green sprangletop.

[2)] Production was determined using a step point method by placing five, 2.4 ft^2 quadrats every 10 steps along a given direction on each key site. The double sampling weight estimate method was used on key sites to determine current year growth. Production data are reported on a dry matter basis.

[3)] Key sites were selected near the south entrance of Chimenea pasture. Shortgrass sites were west and east of the road. Midgrass sites were along the main arroyo.

Appendix Table 7. Species composition and production along channel entrance to Japanese Tank, Ruby Pasture and a transect 17 meters west, adjacent to the channel transect, October, 2003.[1]

Plant species	Percent Composition		Production[2]	
	Channel	Upland	Channel	Upland
			(lbs/ac)	
Plains lovegrass	32.0	48.0	1,305	1,925
Sideoats grama	0.0	12.0		
Green sprangletop	2.0	8.0		
Cane bluestem	4.0	14.0	Ecological Condition	
Paspalum spp.	30.0	2.0	Channel	Upland
Sedge spp.	4.0	0.0	54	92
Hairy grama	4.0	6.0		
Sprucetop grama	0.0	6.0		
Wolftail	0.0	4.0		
Annual grasses	24.0	0.0		
Total	100.0	100.0		

[1)] Two 50 meter transects were located near Japanese Tank. One transect began at a point 20 meters from the waters edge proceeding upstream along channel. The second transect was 30 meters from Japanese Tank and adjacent to first transect. Plant hits were recorded at 1 meter intervals using a Parker ¾ inch loop.

[2)] Production was determined by placing five, 2.4 ft^2 quadrats at 10 meter intervals along each of the 50 meter transects. Plant materials were clipped to ground level weighed in grams and reported on a dry matter basis.

Appendix Table 8. Grazing use on Montana Allotment pastures in 1998, 1999, 2000, 2001, 2002, and 2003.

1998				
		Overall Grazing	Grazing Use	
Pasture	Date	Use	Upland	Riparian
Schumacher	April, November	Conservative-Moderate (30%)	Conservative	Moderate
Ruby	April, November	Light (15%)	Light	Conservative
Warsaw	April, November	Unused (0%)	Unused	Unused
Bolsa	November	Unused (0%)	Unused	Unused
Chimenea	April, November	Moderate (40%)[1]	Conservative	Conservative

1999				
		Overall Grazing	Grazing Use	
Pasture	Date	Use	Upland	Riparian
Schumacher	October	Unused (0%)	Unused	Unused
Ruby	March, October	Light (20%)	Light	Light
Warsaw	March, October	Conservative (34%)	Conservative	Conservative
Bolsa	March, October	Unused (0%)	Unused	Unused
Chimenea	March	Light (25%)	Light	Conservative

2000				
		Overall Grazing	Grazing Use	
Pasture	Date	Use	Upland	Riparian
Schumacher	November	Conservative (37%)	Conservative	Conservative
Ruby	July	Light (20%)	Light	Light
Warsaw	November	Unused (0%)	Unused	Unused
Bolsa	November	Conservative (39%)	Conservative	Conservative
Chimenea	February	Conservative (35%)	Conservative	Conservative

2001				
		Overall Grazing	Grazing Use	
Pasture	Date	Use	Upland	Riparian
Schumacher	September	Unused (0%)	Unused	Unused
Ruby	June	Light (26%)	Light	Moderate
Warsaw	September	Conservative (31%)	Light	Moderate
Bolsa	September	Unused (0%)	Unused	Unused
Chimenea[1]	April	Light (25%)	Light	Conservative

2002				
		Overall Grazing	Grazing Use	
Pasture	Date	Use	Upland	Riparian
Schumacher	September	Conservative (36%)	Conservative	Light
Ruby	May	Light (25%)	Light	Light
Warsaw	September	Unused (0%)	Unused	Unused
Bolsa	September	Light (25%)	Light	Light
Chimenea[1]	April	Light (30%)	Conservative	Light

2003				
		Overall Grazing	Grazing Use	
Pasture	Date	Use	Upland	Riparian
Schumacher	October	Unused (0%)	Unused	Unused
Ruby	July	Conservative (32%)	Conservative	Conservative
Warsaw	October	Light (21%)	Light	Light
Bolsa	October	Unused (0%)	Unused	Unused
Chimenea	May	Moderate (33%)[2]	Moderate	Moderate

[1]Forest Service personnel evaluated grazing use on key areas to be 40%.
[2]Forest Service personnel estimated grazing use on key areas to be 44%. Our estimate of grazing use across the entire pasture was 33%.

Appendix Table 9. Riparian health scores for 8 sites on the Montana Allotment on September 15-17, 2000. (Holechek et al. 2001)

Riparian Characteristic	Site							
	Vernon Dale	Tinaja	Casa Piedra	Forest Service Exclosure	California Gulch	Lower Tinaja	Black Diamond	Warsaw
Parameter								
Riparian vegetation structural diversity	4	4	4	4	4	4	4	4
Bank Stability	4	4	4	4	4	4	4	4
Vegetation Cover	3	4	3	3	2	3	3	2
Buffer Width	3	4	4	4	4	4	4	4
Vegetation Diversity	4	4	4	4	4	4	4	4
Embeddedness	4	3	3	3	3	3	3	3
Canopy Shading	4	3	2	4	2	3	4	3
Width/Depth Ratio	4	3	3	2	2	3	3	3
Pool/Riffle Ratio	3	4	3	4	*	*	*	*
Streambed Geology	4	4	4	4	4	4	4	4
Score	37	37	34	36	29	32	33	31
Score/#parameters	3.7	3.7	3.4	3.6	3.2	3.6	3.7	3.4
Rating	Excellent	Excellent	Good	Excellent	Good	Excellent	Excellent	Good

*Stream dry.

Appendix Table 10. Sediment yield and soil loss rates on the Montana Allotment, Arivaca, Arizona.

Stock Pond	Watershed Area (acres)	Pond Age (years)	Sediment Weight (tons)	Sediment Yield (tons/acre/year)	Soil Loss[1] (tons/acre/year)
Japanese	109	16	514	0.29	0.58
Narrows	58	9	84	0.16	0.32
Warsaw	51	72	832	0.23	0.46
Lower Warsaw	90	9	71	0.09	0.18
Company Well	58	9	63	0.12	0.24
Nogalito	35	9	123	0.39	0.78
Mujeres	77	56	804	0.19	0.38
Alto Schumacher					
old	147	44	316	0.05	0.10
new	147	9	43	0.03	0.06
Pico	50	15	367	0.24	0.48
Average	91			0.16	0.32

[1)] Sediment delivery ratio is considered to be 0.5 based on Brooks et al. (1997).
[2)] Natural rate of erosion is considered to be 0.32 tons/acre/year.

Appendix Table 11. Descriptions of Livestock developments on Montana Allotment that have been installed since 1998 to 2003.

Warsaw Pasture

A well was developed at the Grubstake Mine which is located in the southeast part of the pasture. A solar pump was installed on the well and a pipeline, 2000 ft. was laid uphill to a 5,000 gal. storage tank and water trough. Also a pipeline was installed from the Grubstake Mine storage tank to a water trough 2,000 ft. down in Holden Canyon west of the Grubstake Mine well and storage tank.

Excessive seepage in Holden tank, located in north central Warsaw, was repaired by adding 5 tons of bentonite. The tank has held water all this year. Nogalito tank was fenced to exclude cattle as needed.

Schumacher Pasture

A pipeline was extended from Schumacher spring in east part of pasture about 1 mile southwest of Schumacher tank. This included 1,500 ft. of steel pipe to two 5,000 gal. storage tanks and a water trough. Rebuilt hidden tank in Schumacher.

Ruby Pasture

A water trough was installed below Eagle tank about 0.5 miles east of the town of Ruby.

An 8,000 gal. storage tank and trough was installed at a point of intersection of Schumacher, Warsaw and Ruby pastures. Water is pumped from a well 0.25 miles south of the storage tank in west Schumacher.

A new pipeline was installed from Figtree spring, 300 ft. to a water trough.

Chimenea Pasture

A new well was drilled in north Chimenea. The well is pumped by a solar pumpjack system to a 3,000 gal. storage tank and water trough. Rebuilt Choctaw tank spillway.

Bolsa Pasture

Rebuilt Bolsa tank.